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June 1, 1976 - May 31, 1977

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Technical Monitor

Volume I of III

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1977

PURDUE UNIVERSITY
LABORATORY FOR APPLICATIONS OF REMOTE SENSING

June 28, 1977

National Aeronautics and Space
Administration
Scientific and Technical
Information Facility, Code KS
Washington, D.C. 20546

Dear Sirs:

The report listed below is submitted in accord with Contract NAS9-14970, Article XVI - Reports of Work and Documentation.

"Final Technical Report", Volumes I, II, and III, NASA Contract NAS9-14970, June 1, 1976 - May 31, 1977 by the Laboratory for Applications of Remote Sensing.

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Very truly yours,

D. A. Landgrebe
Director, LARS

DAL:jh
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Preface

This report provides a summary of results for the past year's effort under contract NAS9-14970. The contract called for work on a wide variety of separate and distinct but related tasks. Below is a list of the tasks as contained in the original Work Statement.

As a result of this contract a large volume of results has been generated. Technical and research reports previously submitted or presently being published are listed in Table I.

Because of the diversity present in the task list for the contract, each major subdivision of this report has been written to be relatively self-contained. We hope this will facilitate use of the report by readers with different interests.

Many of the tasks below are continuing; as a result, the discussion presented relative to them constitutes a progress report. Task 2.1 and 2.2 are not continuing, thus the discussion relative to them is more complete.

The various tasks have been managed by various Purdue staff members during the year. It is appropriate that the contributions of these people be recognized.

Task	Purdue Task Manager
2.1 Test of Boundary Finding/Per Field Classification (ECHO)	P.H. Swain
2.2 Stratification of Scene Characteristics	P.H. Swain
2.2a Stratification by Machine Clustering	
2.2b Digitization and Registration of Ancillary Data	
2.2c Crop Inventory Using Full-Frame Classification	
2.3 LACIE Field Measurements	M.E. Bauer
2.4 Scanner System Parameter Selection	P.A. Anuta
2.5 Technology Transfer	J.C. Lindenlaub
2.6 Large Area Crop Inventory Design	M.E. Bauer
2.7 Forestry Applications Project	R.P. Mroczynski
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2.9 Interpretation of Thermal Band Data	L.F. Silva
2.10 Super Site Data Management	L.F. Silva
2.11 Soil Classification and Survey	M.F. Baumgardner
2.12 Improved Analysis Techniques for Multitemporal Data	P.H. Swain

The efforts of Dr. J.D. Erickson, the contract Technical Monitor and Mr. M.C. Trichel are especially to be noted and greatfully acknowledged.

Table I. Technical and Research Reports

052977 Davis. The Focus Series: A Collection of Single-Concept Remote Sensing Educational Materials.

042777 Russell and Lindenlaub. Disseminating Technological Information on Remote Sensing to Potential Users.

120776 Vanderbilt, Silva and Bauer. A Laser Technique for Characterizing the Geometry of Plant Canopies.

091576 DeWitt and Robinson. Description and Evaluation of a Bidirectional Reflectance Factor Reflectometer.

070676 Kristof, Russell, Cary, Lube and Weismiller. Determining Land Use Patterns Through Man-Machine Analysis of LANDSAT Data - A Tutorial Simulation.

111076 Russell. Systematically Disseminating Technological Information to Potential Users.

110976 Landgrebe, Simmons and Biehl. An Empirical Study of Scanner System Parameters.

090776 Svedlow, McGillem, and Anuta. Analytical and Experimental Design and Analysis of an Optimal Processor for Image Registration.

082776 Montgomery, Baumgardner and Weismiller. An Investigation of the Relationship Between Spectral Reflectance and the Chemical, Physical, and Genetic Characteristics of Soils.

062176 Wiersma and Landgrebe. The Use of Spatial Characteristics for the Improvement of Multispectral Classification of Remotely Sensed Data.

052576 Lindenlaub and Lube. Matrix of Education of Training Materials in Remote Sensing.

051576 Bauer and Davis. Stratification of Landsat Data by Clustering.

*032576 Todd, Mausel, and Baumgardner. Urban Land Use Monitoring from Computer-Implemented Processing of Airborne Multispectral Data.

*031276 Mausel, Todd and Baumgardner. An Analysis of Metropolitan Land-Use by Machine Processing of Earth Resources Technology Satellite Data.

052075 DeWitt and Robinson. Description and Operation of a Field Rated ERTS-Band Transmissometer.

* Papers reporting earlier SRT work which has just appeared in print.

OTHER REPORTS

Biehl and Simmons.
Field Measurements Data Library Catalog, Volume I, 1974-75 Crop.
October 29, 1976.

Biehl and Simmons.
Field Measurements Data Library Catalog, Volume II, 1975-76 Crop.
December 1, 1976.

2.1 Test of Boundry Finding/Per field Classification

INTRODUCTION

One might wish to adopt a new classification technique for one of three reasons:

- It provides greater accuracy than the currently implemented technique..
- The new technique is less expensive than the current technique.
- The classification results produced by the new technique are easier to use and interpret than those currently produced.

The ECHO* classification algorithms developed at the Laboratory for Applications of Remote Sensing (LARS) have shown promise in all three areas listed above.[1]

Contemporary classifiers for analysis of remotely sensed data compare the spectral measurements from each feature of each point to class statistics, computing a likelihood of discriminant function associated with each class, and categorizing the point according to the class with the largest discriminant function value. Each point is classified individually on the basis of its spectral measurements alone. One premise of this technique is that the objects of interest are large in comparison to the size of a point. If this were not so, a large proportion of points would be composites of several classes, making statistical pattern classification unreliable since pre-specified categories would be inadequate to describe actual states of nature. From this premise it follows that objects are represented by arrays of points, and that a statistical dependence exists between consecutive points. Contemporary classifiers fail to exploit the statistical dependence between adjacent points when assigning classes.

---

*ECHO stands for Extraction and Classification of Homogeneous Objects

Giving no consideration to the spectral response of adjacent points contributes to a "salt and pepper" effect in classification results. While the results produced may be accurate, they may be too complex, and can even be confusing when attempting to produce a useful analysis product such as a forest inventory map.[2] Consequently time and effort have been invested in developing smoothing programs which "clean-up" the "salt and pepper" effects in classification results.[2]

The ECHO processors benefit from spatial information by first aggregating into groups points whose spectral responses are not significantly different in a statistical sense, and then applying a maximum likelihood classification rule to these homogeneous groups. Homogeneous objects are identified in a three step process. First, cells are formed by systematically partitioning the data into N by N sized blocks of pixels. The statistics of each cell are then compared to a homogeneity criterion. Points which do not comprise homogeneous groups are classified on a point-by-point basis, just as contemporary classifiers classify all points. Statistics of adjoining homogeneous cells are then compared to annexation thresholds. Adjoining cells which appear to belong to the same statistical population are combined into a single object.

Two separate ECHO algorithms have been developed. The first, Supervised ECHO, makes use of pre-specified class statistics to identify homogeneous objects. The second, Nonsupervised ECHO, identifies homogeneous objects without the use of class statistics. Consequently, those objects identified by the Nonsupervised algorithm may be used to aid in the training process.

Past Work at LARS

Much of the background research on the ECHO concept was performed at LARS during 1975 and is documented in the Final Report for 1975,[3] R. L. Ketting's

doctoral thesis,[1] a LARS Information Note,[4] and in symposium proceedings.[5]

The partitioning of a data set into homogeneous objects can occur in one of two general approaches. One can utilize a disjunctive approach, starting with large areas and repeatedly subdividing them until each unit appears to be homogeneous. Alternatively, one can choose a conjunctive approach where adjacent units which appear to belong to a single object are combined. One advantage to the conjunctive approach is, if second order statistics are to be used, the second order statistics of the combined area can be calculated from the second order statistics of each constituent unit. The statistics for each subdivision of the initial partition made under the disjunctive approach must be recalculated starting with the individual pixel values, however. Hence the conjunctive approach is potentially faster than the disjunctive approach.

Prior to the 1975 work, Rodd's conjunctive partitioning algorithm[6] was combined with a minimum distance sample classifier and an improvement in classification accuracy over conventional classification was observed, however processing time was increased.[4] Gupta and Wintz,[7] added a second order statistics test to Rodd's first order test, but obtained essentially the same results at an increase in processing time. Robertson[8] implemented a disjunctive partitioning algorithm with a minimum distance classifier which acheived the same classification accuracy as the conventional point-by-point classifier with an order of magnitude increase in computer time.

During 1975 new statistical criteria were applied to the partitioning algorithm producing a "Supervised" field extraction routine to add to the Nonsupervised routine. In addition, the sample classifier utilized by ECHO was altered from a minimum distance strategy to a maximum likelihood strategy. Experimental results were obtained for two aircraft and two LANDSAT-1 data sets which indicated that ECHO algorithms improved classification accuracies for the four tested areas and that they reduced the CPU

time required to perform the classifications.

FORTRAN programs were produced implementing the Supervised and Nonsupervised algorithms in two phases. Channel selection, cell size, and cell homogeneity criteria were specified in the first phase of the Supervised processor, annexation in the second. For the Nonsupervised processor, only channel selection and cell size were specified in phase one, cell homogeneity and annexation thresholds were specified in phase two. The Nonsupervised processor did not have the capability to "split" cells; i.e. the constituent points in a singular cell had to be classified as a small sample rather than point-by-point.

Documentation of these programs consisted of commented program listings and a thesis.[3]

Objectives of the 1976-1977 Task

The objectives of the FY77 work were to:

1) Deliver to NASA documented FORTRAN programs implementing the ECHO algorithms, and to make improvements to those algorithms, where appropriate.

2) Systematically test the algorithms on MSS data for agricultural regions as observed by the LANDSAT satellites, aircraft scanners, and on the simulated Thematic Mapper data.

3) Provide products enabling the determination of the utility of the object maps to a LACIE Analyst Interpreter in the selection and labeling of training fields.

DESCRIPTION OF WORK

A. Documented Fortran Programs

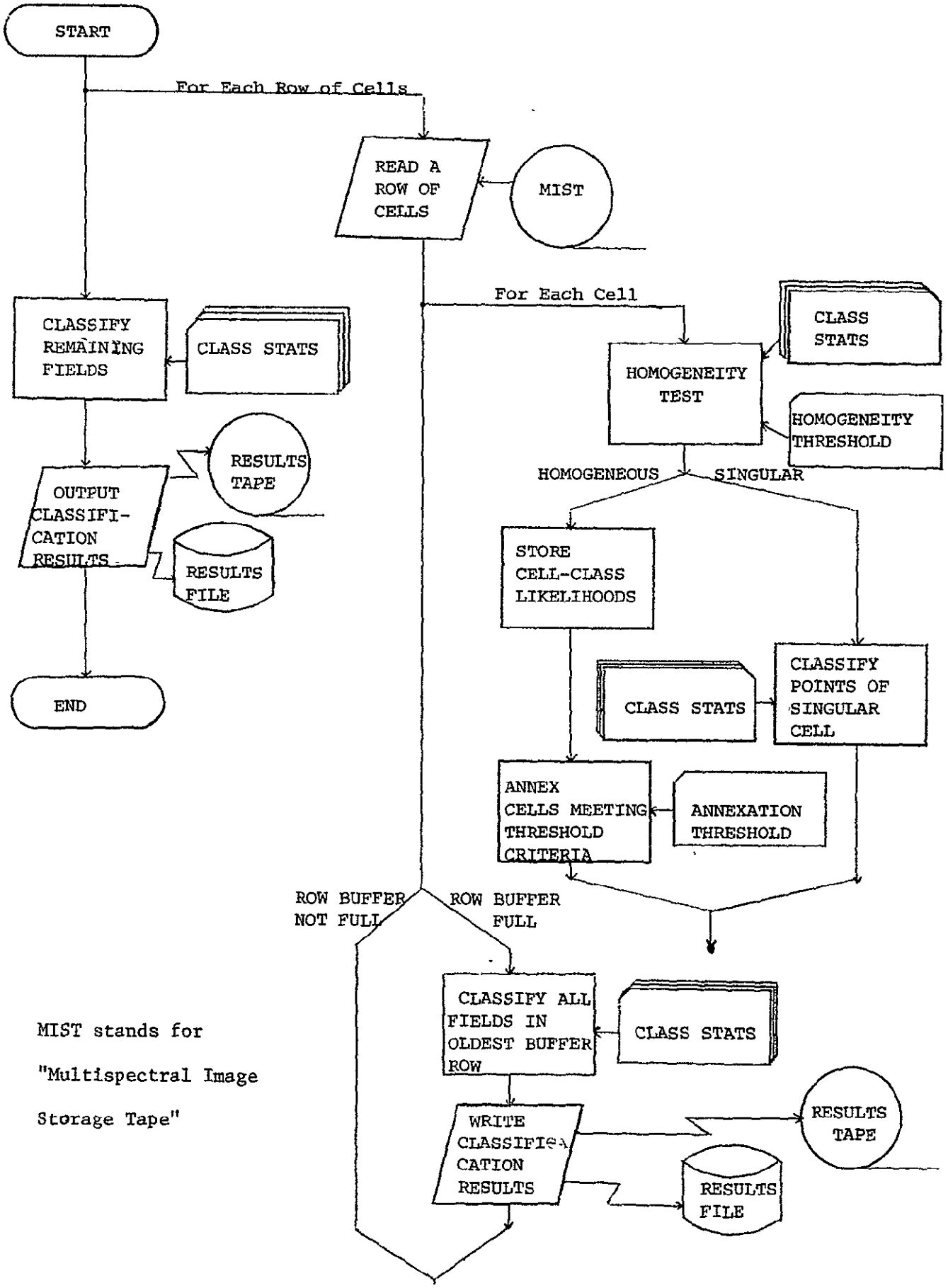
1. Supervised Processor

FORTRAN listings and program abstracts for the Supervised ECHO processor are presented in Appendix A. This processor requires class statistics for field extraction as well as for classification. The general flow of this algorithm is presented in Figure 1. The software is designed to function in either a single phase or a two phase mode. The two phase approach accomplishes channel selection, cell size, and cell homogeneity criteria in phase one; annexation tests take place during phase two. The intermediate results between phases are stored on magnetic tapes. The final results are written either on disk or on tape. Functioning in the two phase mode allows the analyst to vary the annexation threshold and, thus, to produce several results outputs without repeating the expensive cell homogeneity test.

The single step approach allows the analyst to specify all the necessary input parameters on a single control card deck and produce classification results without the necessity of an intermediate tape. When the analyst wishes to produce classifications with varying annexation thresholds for a particular area, it is less expensive in terms of computer time to utilize the two phase approach. When a single annexation threshold is desired, it is more efficient to use the single phase approach. The Supervised ECHO processor determines whether a single phase classification, the first phase of a two phase classification, or the second phase of a two phase classification is to be generated based on the control cards specified.

FIGURE 1

SUPERVISED ECHO FLOW



MIST stands for "Multispectral Image Storage Tape"

Input and output requirements for each processing mode of the Supervised processor are summarized in Table 2.1-1 and Table 2.1-2.

TABLE 2.1-1

Supervised ECHO

Single Phase Mode

Input	Output
Cell Width Parameter	Results File
Cell Homogeneity Threshold	Classification Map (optional)
Annexation Threshold	Singular Cell Map (optional)
Channel Selection	
Specification of the Area to Classify	
Multispectral Image Storage Tape (MIST)	
Specification of Results Destination	
Class Statistics	

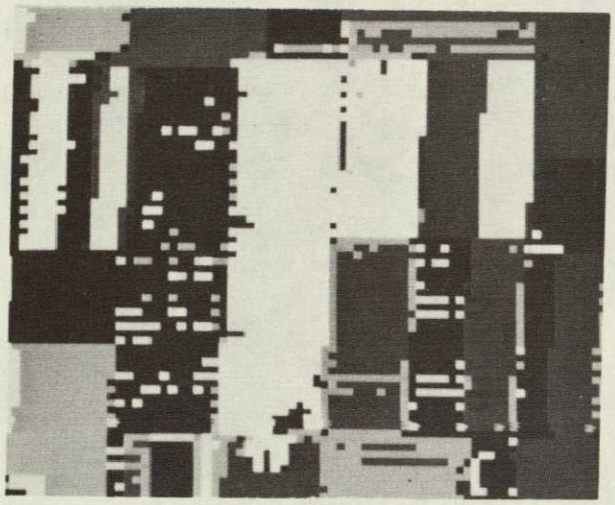
TABLE 2.1-2

Two Phase Mode

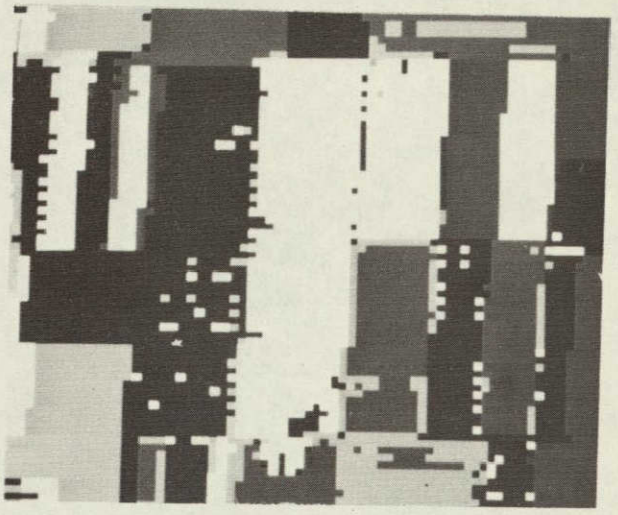
Supervised ECHO

Input	Output
Phase One	
Cell Width Parameter	Intermediate Results Tape
Cell Homogeneity Threshold	Singular Cell Map (optional)
Channel Selection	
Specification of the Area to Classify	
Multispectral Image Storage Tape	
Intermediate Tape and File Specifications	
Class Statistics	
Phase Two	
Intermediate Results Tape File	Results File
	Classification Map (optional)
Annexation Threshold	
Specification of Results Destination	

Figure 2
Effects of Cell Homogeneity Threshold

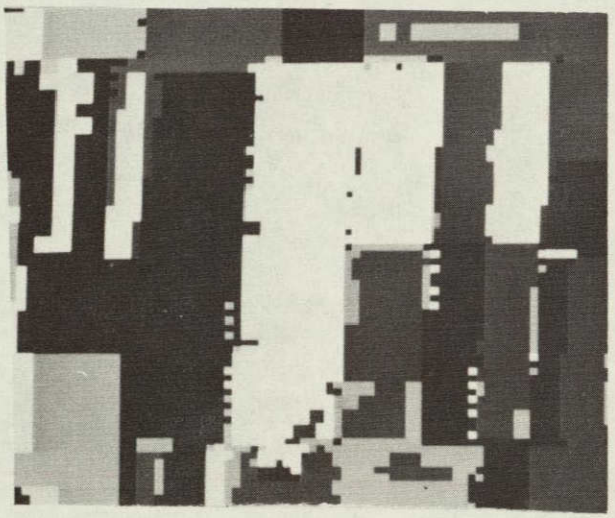


Perpoint

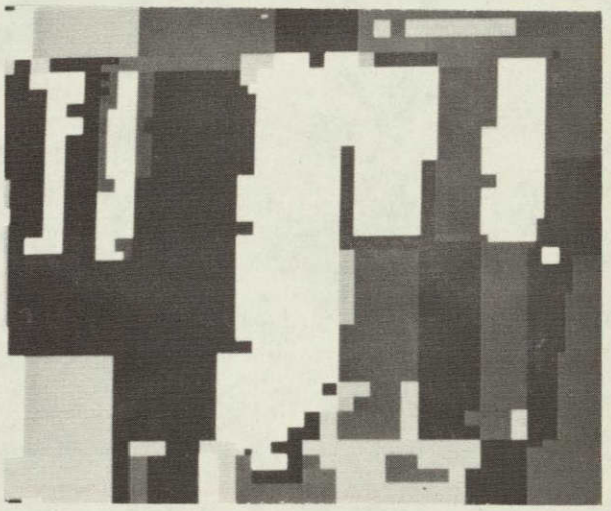


Low Homogeneity Threshold

87.5%	Field Center Pixel Performance	90.0%
7.3%	RMS Proportion Error	2.5%
1200 Seconds	CPU Time	754 Seconds
34.8%	Classification Variability	29.9%



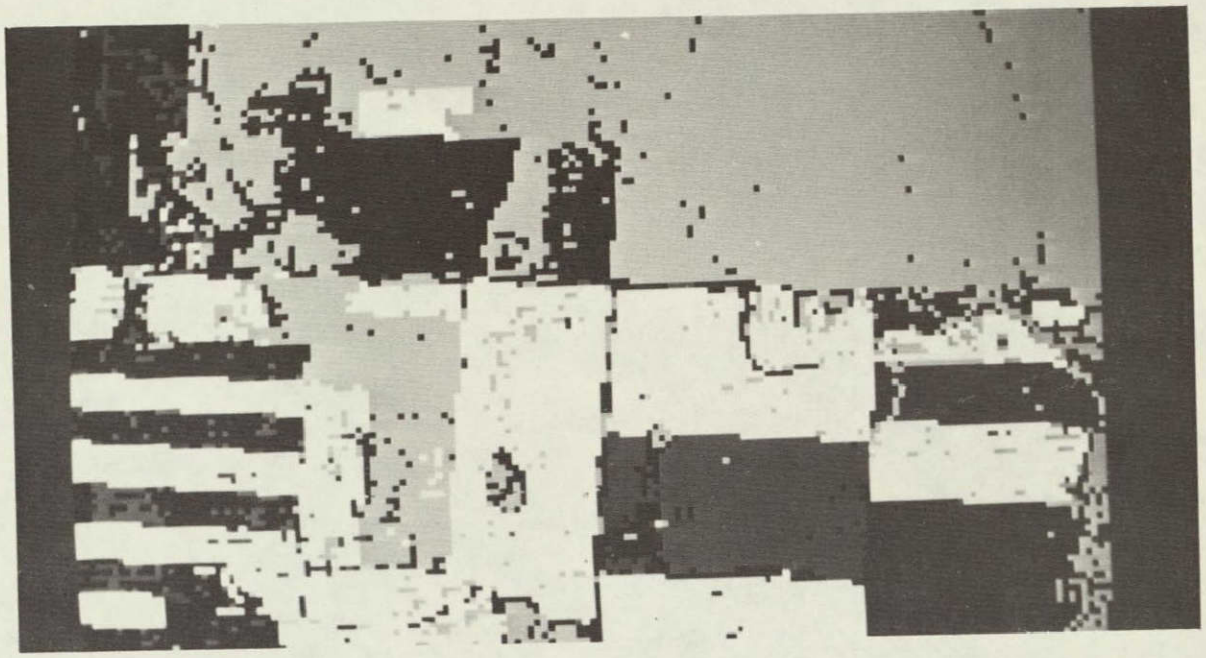
Medium Homogeneity Threshold

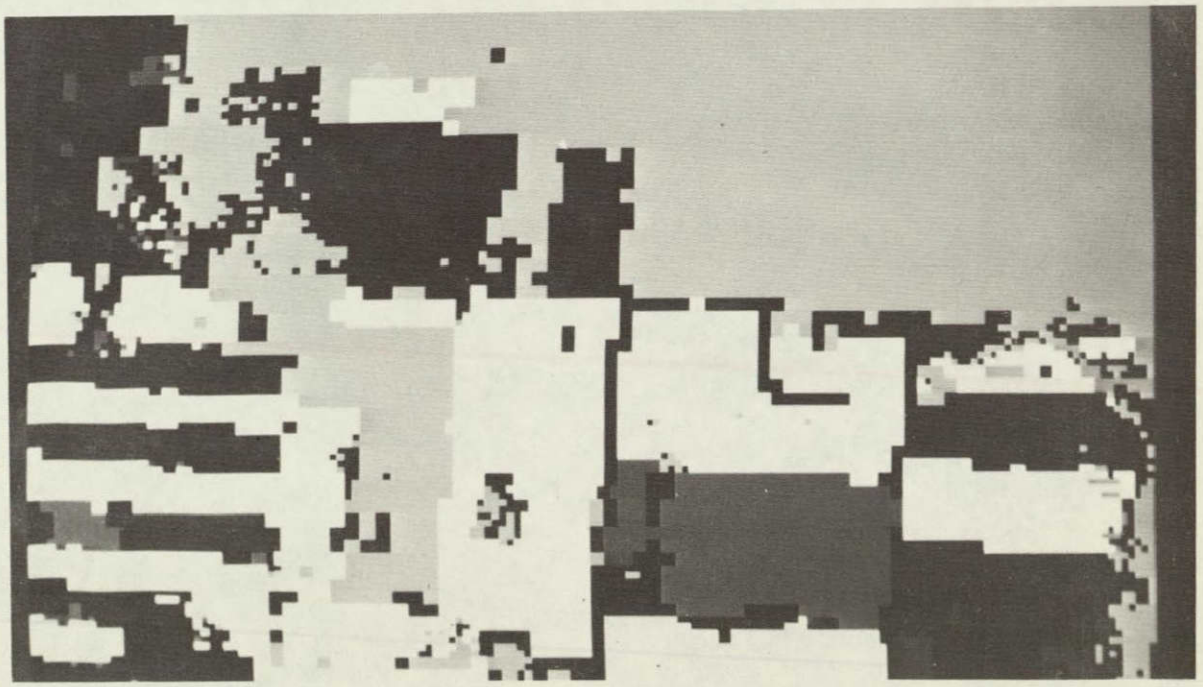


Large Homogeneity Threshold

91.4%	Field Center Pixel Performance	90.7%
2.5%	RMS Proportion Error	2.8%
494 Seconds	CPU Time	370 Seconds
22.5%	Classification Variability	18.6%

Figure 3





Photographs of classification results of aircraft data collected over Williams County, Kansas. Notice the "salt and pepper" in the perpoint results (above). The ECHO results (below) have both higher classification performance and lower classification variability. The ECHO classification was produced using 40% of the CPU time required to produce the perpoint classification.

2. Nonsupervised Processor

Output products for this task included those allowing the determination of the utility of the resulting object map to the LACIE Analyst Interpreter for identifying and labeling training fields. Since the Supervised processor utilizes class statistics for the identification of homogeneous objects, it has only limited value as a training aid. The Nonsupervised processor, on the other hand, does not require class statistics for object extraction, and thus, may prove quite beneficial as a training aid, serving, in a sense, as a spatial clustering algorithm.

The Nonsupervised processor utilizes a homogeneity test which compares σ_{ij}/μ_{ij} to a threshold t_i; where i refers to feature or channel and j refers to the cell. If the standard deviation divided by the mean for feature i exceeds the user-specified threshold t_i, the cell is "singular" and elements of the cell will be classified on a point-by-point basis. Cells are annexed to fields on the basis of a two-step test, 1) that the channel variances of the field are equivalent to the channel variances of the cell and 2) that the channel means of the field are equivalent to the channel means of the cell. Should either of these criteria not be met for any channel, annexation will not take place.

The research software was designed to run in two phases. The first phase merely calculated the cell mean and covariance matrices and wrote them on tape; the second phase proceeded to perform field extraction followed by classification. This process has two disadvantages. First, although an object map could be produced, it had to be produced in phase two, the same phase that required a class statistics deck for input in order to perform the classification. Second, since only cell mean and covariance matrices were written on the intermediate tape, when singular cells were

identified in phase two, they had to be classified as small samples, a cell at a time, rather than on a point-by-point basis, because data values for individual points were not available to the phase two classifier.

The software was restructured to move the field extraction algorithm into phase one of the processor and produce an intermediate tape which contains:

1. class means and covariance matrices for each homogeneous object identified.
2. an object map containing the mean for channel i of object j in every pixel of object j and the original data values for those pixels belonging to singular cells.
3. a tag array identifying whether a pixel falls in a singular cell (and should be classified individually), or in a homogeneous object (and hence should receive a class assignment based on the sample classification of the object to which it belongs).

The second phase of the restructured Nonsupervised processor reads the intermediate tape and the class statistics deck, performs a maximum likelihood sample classification (utilizing second order statistics where possible) on the objects identified, and a maximum likelihood point-by-point classification on points falling in singular cells. Figure 4A presents the general processing flow for phase one (field extraction) of the Nonsupervised processor. The general processing flow for phase two (classification) is presented in Figure 4B. Inputs to outputs from the Nonsupervised ECHO processor's two phases are described in Table 2.1-3.

FIGURE 4A

GENERAL FLOW OF

NONSUPERVISED ECHO

PHASE 1

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

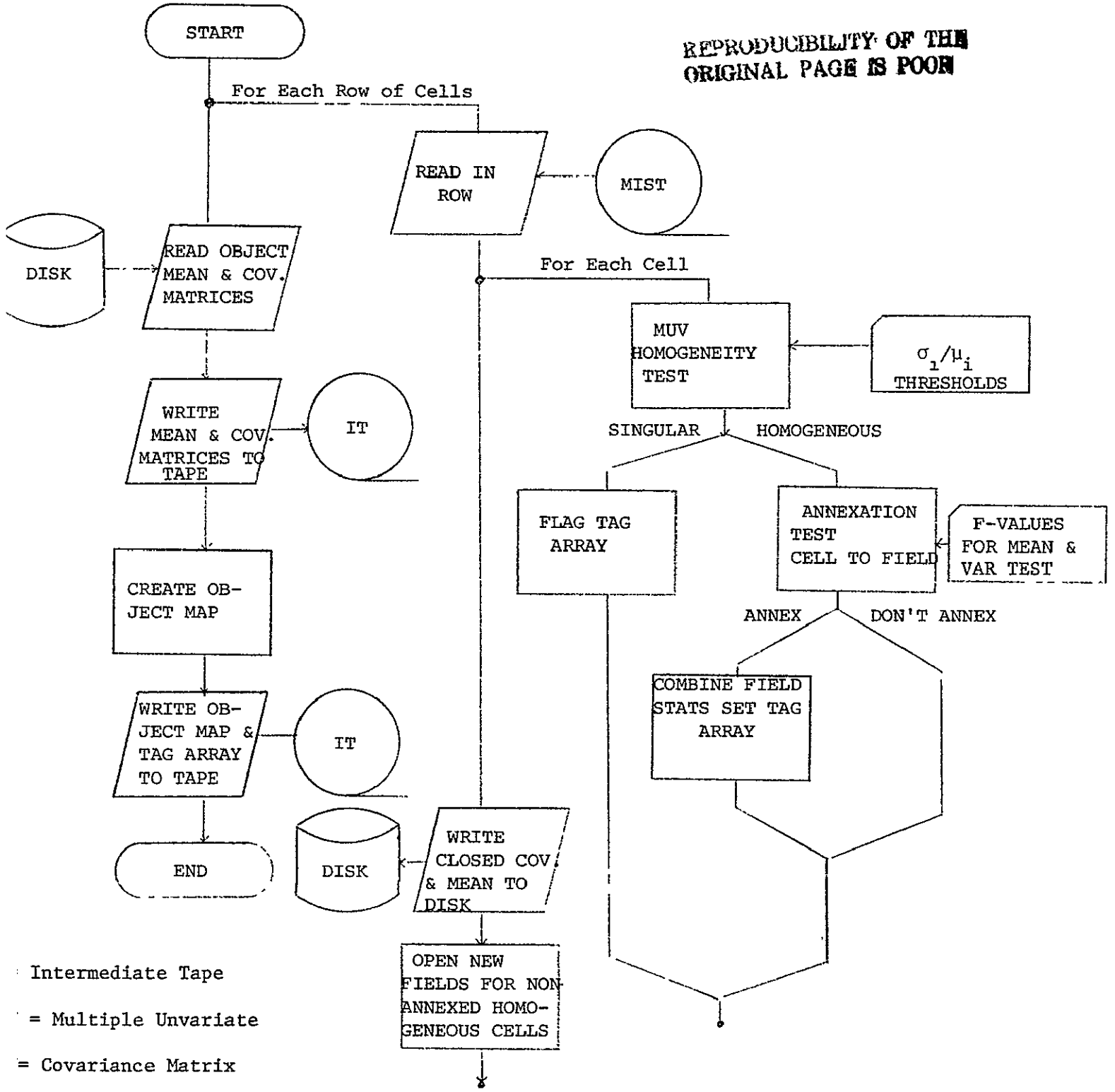


FIGURE 4B

GENERAL FLOW OF

NONSUPERVISED ECHO

PHASE 2

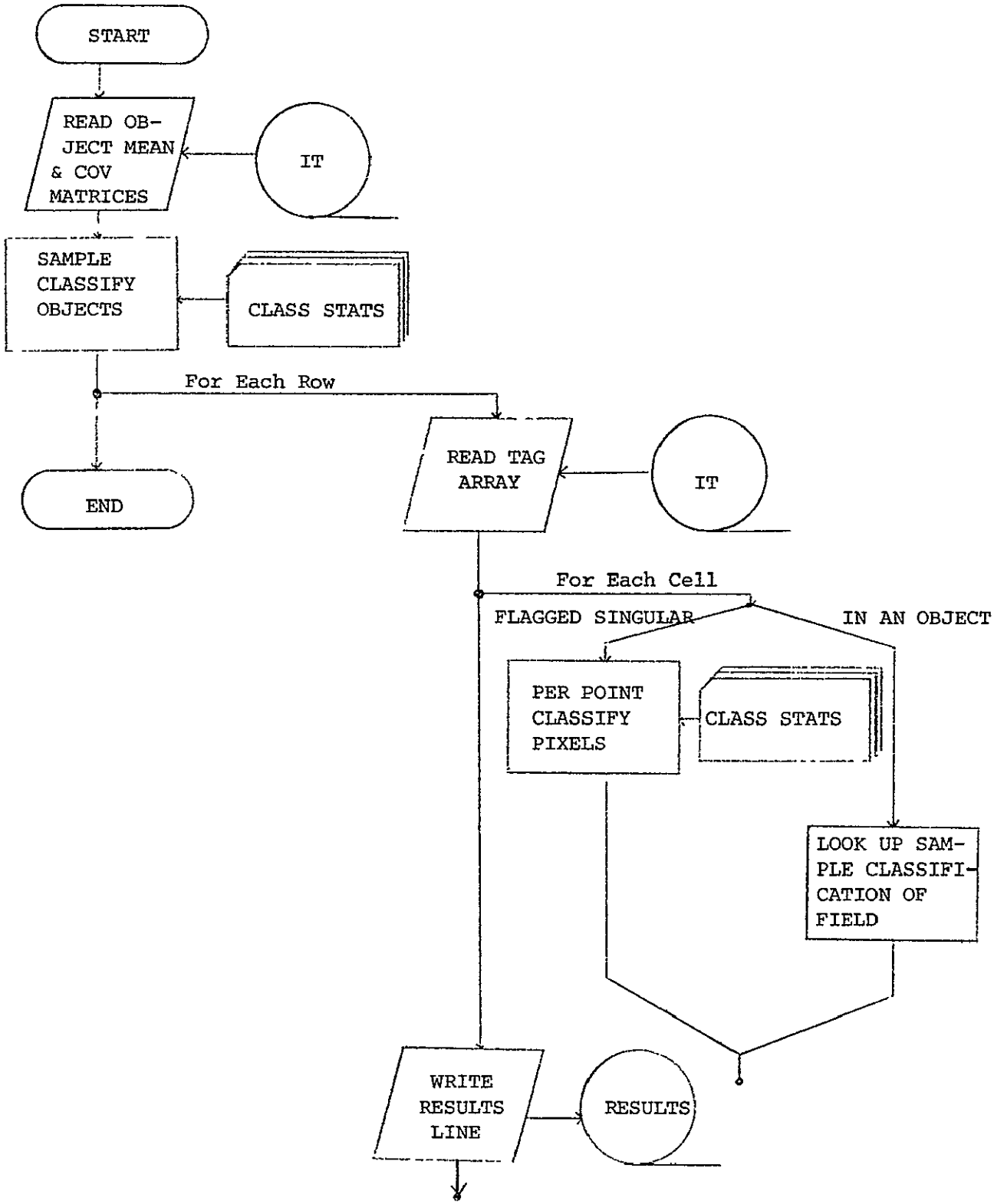


TABLE 2.1-3

NONSUPERVISED ECHO

PROCESSOR

INPUT	OUTPUT
Phase One:	
Channel Selection	Intermediate Tape containing
Cell Width	object map, object statistics
Cell Homogeneity Thresholds	and pixel tag array.
(σ_i/μ_i for channel i)	
Annexation Thresholds	
(mean and variance)	
Multispectral Image Storage	
Tape	
Intermediate Results Tape	
and File Specification	
Phase Two:	
Class Statistics	Results File
Intermediate Tape from	
Phase One	
Specification of Results	
Tape and File	

B. Tests of the ECHO algorithms

1. Data Sets

The second obejctive of Task 2.1 is to test the ECHO algorithms on MSS data for agricultural regions. Data sets are to include LANDSAT, aircraft, and simulated Thematic Mapper data. Ten LANDSAT, three aircraft and eight simulated Thematic Mapper (2 sites and 4 resolutions) data sets were selected for the analysis. One bitemporal data set was examined separately. These data sets are summarized in Table 2.1-4

TABLE 2.1-4

Data Sets

(LANDSAT)

CHANNEL NUMBER	WAVE BAND μM
1,5,9	.5-.6
2,6,10	.6-.7
3,7,11	.7-.8
4,8,12	.8-1.1

Area	Channels Used	Data Collected	Data Set
Graham County, Kansas	9, 10, 11, 12	5/26/74	LACIE/SRS
Grant County, Kansas	5, 6, 7, 8	5/19/74	LACIE/SRS
Haskell County, Kansas	9, 10, 11, 12	5/27/74	LACIE/SRS
Kearny County, Kansas	9, 10, 11, 12	5/27/74	LACIE/SRS
Huntington County, Indiana	1, 2, 3, 4,	7/7/73	CITARS
Shelby County, Indiana	1, 2, 3, 4	9/7/73	CITARS
White County, Indiana	1, 2, 3, 4	8/21/73	CITARS
Livingston County, Illinois	1, 2, 3, 4	7/16/73	CITARS
Fayette County, Illinois	1, 2, 3, 4	8/21/73	CITARS
Lee County, Illinois	1, 2, 3, 4	8/5/73	CITARS

TABLE 2.1-4 (Continued)

Simulated Thematic Mapper

TM CHANNEL NUMBER	WAVE BAND μM
1	.45-.52
2	.52-.60
3	.63-.69
4	.74-.80
5	.80-.91
6	1.55-1.75
7	10.4-12.5
8	.74-.91

Area	Channels Used	Date	Resolution
Williams County, ND	1, 2, 3, 6, 8	8/15/75	30m
Williams County, ND	1, 2, 3, 6, 8	8/15/75	40m
Williams County, ND	1, 2, 3, 6, 8	8/15/75	50m
Williams County, ND	1, 2, 3, 6, 8	8/15/75	60m
Finney County, Kansas	2, 3, 5, 6, 7	7/6/75	30m
Finney County, Kansas	2, 3, 5, 6, 7	7/6/75	40m
Finney County, Kansas	2, 3, 5, 6, 7	7/6/75	50m
Finney County, Kansas	2, 3, 5, 6, 7	7/6/75	60m

TABLE 2.1-4 (Continued)

Aircraft

Area	Wavebands Used (μM)	Data Collected
Williams County, ND	.4-.49, .59-.64, .65-.69,	8/15/75
Finney County, Kansas	.82-.88, 1.53-1.62, 10.1-11.0	7/6/75
Tippecanoe County, IN	.52-.57, .61-.70, .72-.92, 1.0-1.4, 1.5-1.8	8/13/71

Bitemporal

Area	Wavebands Used for Each Date	Dates	Data Set
Grant County, Kansas	.5-.6, .6-.7,	5/9/74	LACIE/SRS
	.7-.8, .8-1.1	6/14/74	

2. Training Procedures

a. LANDSAT Data Sets

The LACIE training sets were created using ground truth information provided by JSC for both test and training fields. Odd-numbered fields appearing in each subclass were used for training; even-numbered fields were used for test. For Graham and Grant counties, statistics were generated by using the STATISTICS processor. For Haskell and Kearny counties statistics were secured by clustering the training fields of each class into four subclasses which were then pooled on the basis of output from the SEPARABILITY processor. It should be noted that both training and test fields for the LACIE/SRS data are large enough to inset field boundaries approximately two pixels inside estimated field boundaries. This inset allows for any image misregistration which may occur between any two dates on the multitemporal input runs. Proportion estimates for the 1974 LACIE/SRS segments were provided in ground truth packets provided by JSC.

The CITARS training sets were originally created by a supervised procedure using ground truth information provided by the Agricultural Stabilization and Conservation Services (ASCS) to select both the training and test fields.[9] Those training sets were used without change in the ECHO tests.

Six counties in the CITARS experiment were used as test sites. A data set free of clouds which occured late in the growing season was required for each of the six counties. Dates from July, August or early September were selected. The classification results for all of the CITARS experiments are catalogued on a series of LARS tapes. The desired data sets were located on the catalogued CITARS tapes and the statistics which had been used for the CITARS experiment were obtained by using the LARSYS PUNCHSTATISTICS processor. The pooling of classes was determined by running

the PRINTRESULTS processor and requesting training field results. This combination of requests produces a table of available classes in the statistics deck and also the informational names under which they were classified. By using this list it was possible to reconstruct the combinations of spectral classes and pooled spectral classes which were needed to reproduce the original classification.

Training and test fields for each CITARS classification were secured and appropriate control cards added to evaluate the ECHO classifications of CITARS data sets. The proportion estimates used for the CITARS evaluation are estimates of the proportions of the various classes for the entire county made by the SRS.

b. Simulated Thematic Mapper Data Sets

Training sets from the simulated Thematic Mapper tests performed at LARS in 1976 were used for ECHO analysis. These training sets were generated by selecting fields of known cover types and clustering each informational class separately to define subclasses.

Color infrared photographic mosaic prints were made from photographic data collected concurrently with the scanner data. Informational class information provided by ground observations was transfered to clear plastic overlays on the mosaic print. The analyst could then easily locate the corresponding fields in his cluster maps and assign the field coordinates to the informational classes.

Statistics were calculated for each training area and compared using the SEPARABILITY processor. Similar classes were combined, where indicated, and the data set was used to classify the flightline. Training areas were not excluded from the test fields since the test fields had been preselected for the entire flightline.

Two to four subclasses were found in each informational class. The Kansas flight was an exception. Because of severe line-to-line changes in signal level in the original 6 meter scanner data, the analyst was forced to create more spectral classes to account for the within-class variations due to excessive noise. This was most apparent in the 30 and 40 meter resolution data. The effect was reduced but not eliminated in the 50 and 60 meter resolution data. Alternate fields were used for training and test decks, respectively. The procedure was repeated for each of the four resolution sizes. As resolution size increased, the number of spectral classes decreased.

The entire training set selection procedure was repeated for each resolution size so that any effects on training set selection which might be caused by data resolution would be included in the analysis results. An example is the increasing difficulty and eventual impossibility of selecting samples from small, or narrow, fields as the resolution size increases.

c. Aircraft

Six Meter NASA Aircraft Scanner Data

The two 6-meter aircraft scanner data sets used to generate the simulated Thematic Mapper data set were used. The same training and test fields used for the Thematic Mapper were available in the six meter data set. Because of the vary large number of data points in the full data set, only the first two miles (one third of the total flight line) were used for the ECHO evaluations.

These data sets were not corrected for sun and scanner angle effects. To compensate for these angle effects, training fields were distributed across the width of the flight line. At least six fields in each informational class were used in the training set. Fields from informational

classes were clustered together into five spectral classes. All spectral classes from all informational classes were combined into a statistics deck and appropriate pooling was done based on SEPARABILITY results. The classification results were strongly influenced by angle effects.

Flightline 210, Corn Blight Watch Experiment

Training and test fields from the Michigan Scanner data set were located on the LARS display system using ground information collected during the Corn Blight Watch Experiment. At least six fields were selected to represent each informational class. Each informational class was then clustered to produce five spectral subclasses. All spectral classes were combined and processed with SEPARABILITY to select the subset of the original 12 channels which was to be used for classification. A subset of five channels was chosen and the training set was again processed with SEPARABILITY to determine which classes should be pooled.

d. Bitemporal Data Set

A bitemporal data set from Grant County, Kansas was created by selecting data from a spring date and a mid-summer date. Training and test fields were available from the LACIE data and were edited to reduce the number of single line training fields by about 30 percent. Data from the two dates were clustered together within each informational class with four spectral classes requested. Classes were grouped as indicated by the CLUSTER algorithm and classes with fewer than 50 points were deleted.

3. Dependent Variables

There are six variables which were monitored to evaluate the ECHO algorithm:

- CPU time
- Field center pixel classification performance
- Training field classification performance
- Full field classification performance
- RMS proportion estimate error
- Classification variability

These variables are related to the stated reasons for adopting a new classification technique listed in the introduction. The CPU time required to perform a classification is one way to measure the cost of classification. Field center pixel, full field, and training field performances and RMS proportion estimate error are all ways to evaluate the accuracy of the classifier. Classification variability is a measure of "salt and pepper effect" in classification results.

The CPU time required to execute each of the ECHO classifications has been recorded so that the effects of varying the cell homogeneity and annexation thresholds may be monitored. The CPU times required to perform the perpoint classifications have been adjusted to reflect the increased efficiency of the LARSYS perpoint classifier which is coded in assembly language. Thus, the CPU time recorded for a perpoint classification is what a FORTRAN classifier would have required to perform the classification.

The indices of classification performance were applied in several ways. Classification accuracy (identification) was evaluated utilizing field center pixel, "full field" and test field sample performance for all data sets. Proportion estimation was carried out for the LANDSAT

and Simulated Thematic Mapper data sets.

The training performance is the overall classification accuracy (number of training pixels correctly classified divided by the total number of training pixels) of the pixels used to calculate the class statistics. Field center pixel performance is the overall classification accuracy of field center pixels. Field center pixels are pixels inset at least one pixel from the field boundaries. For the registered LACIE/SRS data the field center pixels are inset at least two pixels from the field boundary. Although this procedure insures that the pixels examined are not mixture pixels, it has the unfortunate effect of eliminating smaller fields from consideration. The third measure of classification accuracy, "full field" performance, includes those pixels on the boundaries of the fields in the classification performance. The "full field" pixels were generated by expanding the field center pixel boundaries one pixel in all directions.

The RMS error of informational class proportion estimates for each flightline was found by calculating the percent of the flightline classified as a particular class and comparing it with the ground-collected estimate using equation (1).

$$\text{RMS Error} = \sqrt{\frac{\sum_{i=1}^{N} (C_i - C'_i)^2}{N}} \qquad (1)$$

where, N = number of informational classes

C_i = percent classified as informational class i

C'_i = percent of class i estimated from ground-collected data

RMS error is calculated for the LANDSAT and Thematic Mapper data runs. The Agricultural Stabilization and Conservation Service (ASCS) provided the ground truth proportion estimates for the simulated Thematic

Mapper data set. Proportion estimates for the 1974 LACIE/SRS segments were provided in ground truth packets received from JSC. The SRS county proportion estimates were used to calculate RMS proportion error for the CITARS data set.

Average variability is a measure of the rate of change from one information class to another. It should reflect the degree to which ECHO reduces the "salt and pepper" effect which is sometimes present in per-point classifications. Variability is calculated by systematically selecting 50 lines of the classified area, counting the number of information class changes, and dividing by the number of opportunities for class changes.

$$\text{Variability} = NCC/(50*(NS-1)) \qquad (2)$$

Where

NCC = the number of class changes over the 50 selected lines

NS = the number of classified pixels/line

4. Results

This section outlines the results of the tests performed on the Supervised processor. Results are discussed separately for each scanner type, LANDSAT, simulated Thematic Mapper, and aircraft, followed by a summary of results for all three data types.

a. LANDSAT Results

Training and test information for the 10 data sets comprising the LANDSAT test data were drawn from the 1974 Kansas LACIE/SRS data sets and the 1973 CITARS data sets. One bitemporal and four unitemporal analyses were performed on the LACIE/SRS data sets. Six unitemporal analyses were performed on the CITARS data sets.

i. LACIE/SRS Results

Figures 5 through 10 present the average results for the four LACIE/SRS sites examined at a cell width of two for six cell homogeneity and four annexation parameters. Figure 5 plots the average CPU time in seconds required by the perpoint classifier (represented by the line of P's) versus the CPU time required by the average of the four LACIE/SRS data sets at each of 24 ECHO parameter settings for 2 by 2 pixel cells. The horizontal axis is the cell homogeneity threshold. As this threshold increases, it becomes more likely a cell will be classified as a unit, less likely that a cell will be split and its constituent pixels classified individually. The dependent variable, CPU time, appears on the vertical axis. The cell to field annexation parameter for each cell homogeneity threshold appears on the plot. When two or more annexation thresholds acheive the same performance, a star appears in that position on the plot. It can be seen from Figure 5 that as the cell homogeneity parameter increases, the CPU time required to classify the area decreases. Additionally, as the annexation parameter increases from zero to four, the CPU time required for the classification is reduced. These results are expected because fewer

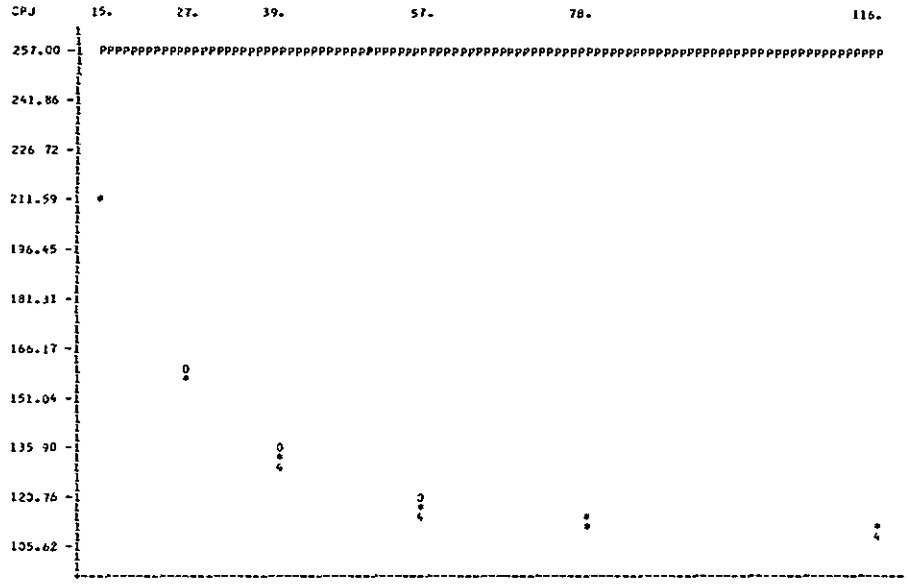


FIGURE 5

LACIE/SRS CPU TIME

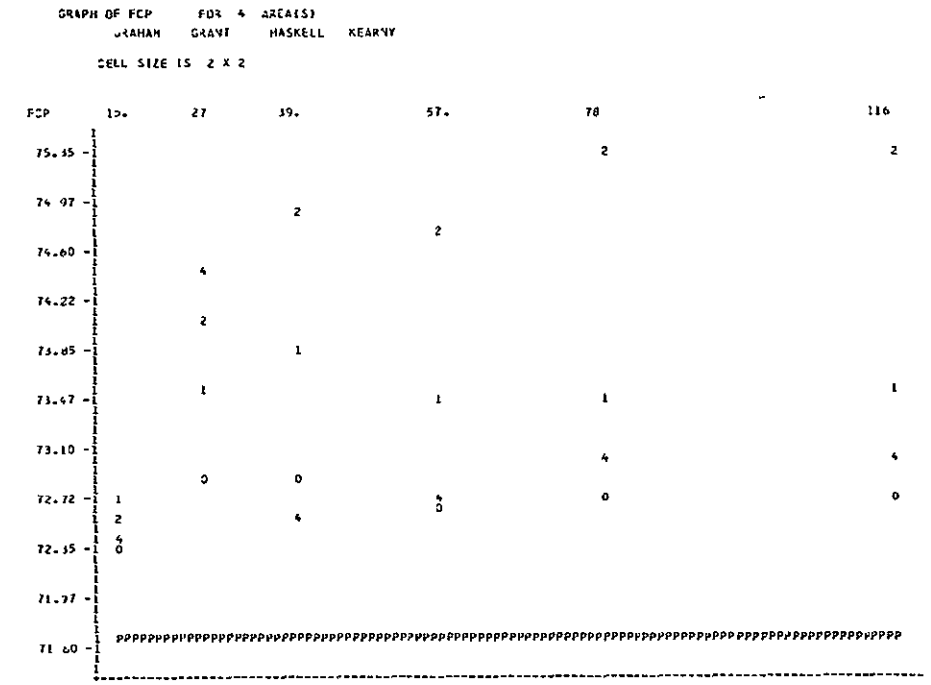


FIGURE 6

LACIE/SRS PILOT CENTER FIXIT PERFORMANCE

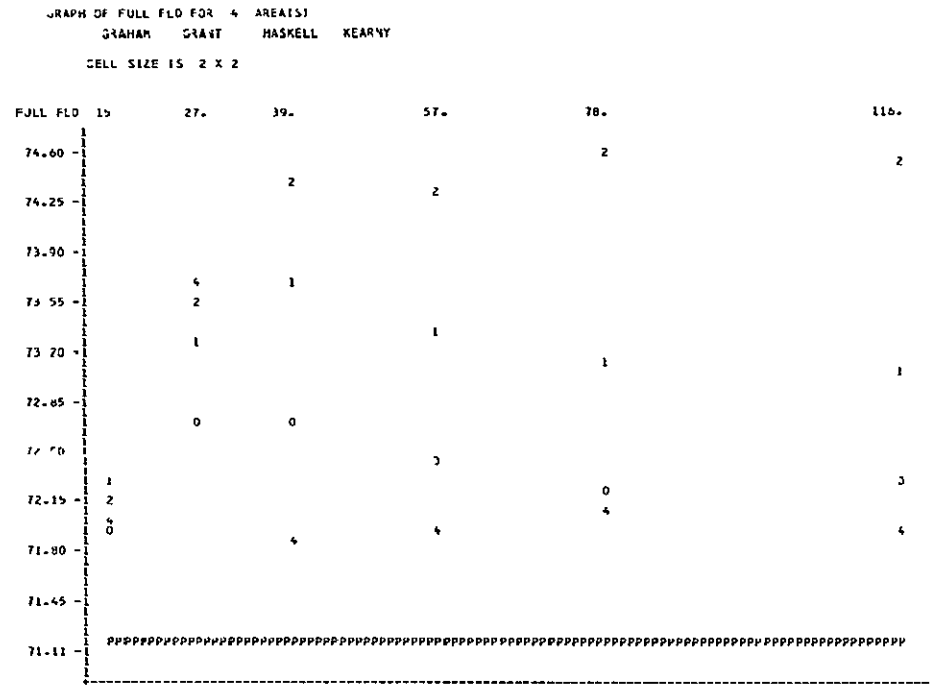


FIGURE 7

LACIE/SRS FULL FIELD PERFORMANCE

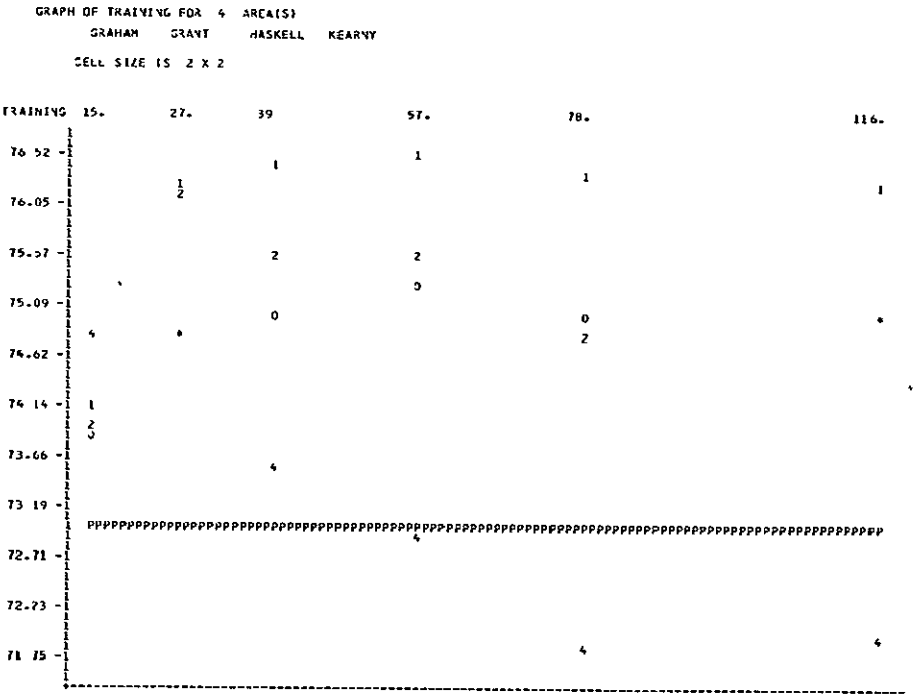


FIGURE 8

LACIE/SRS TRAINING PERFORMANCE

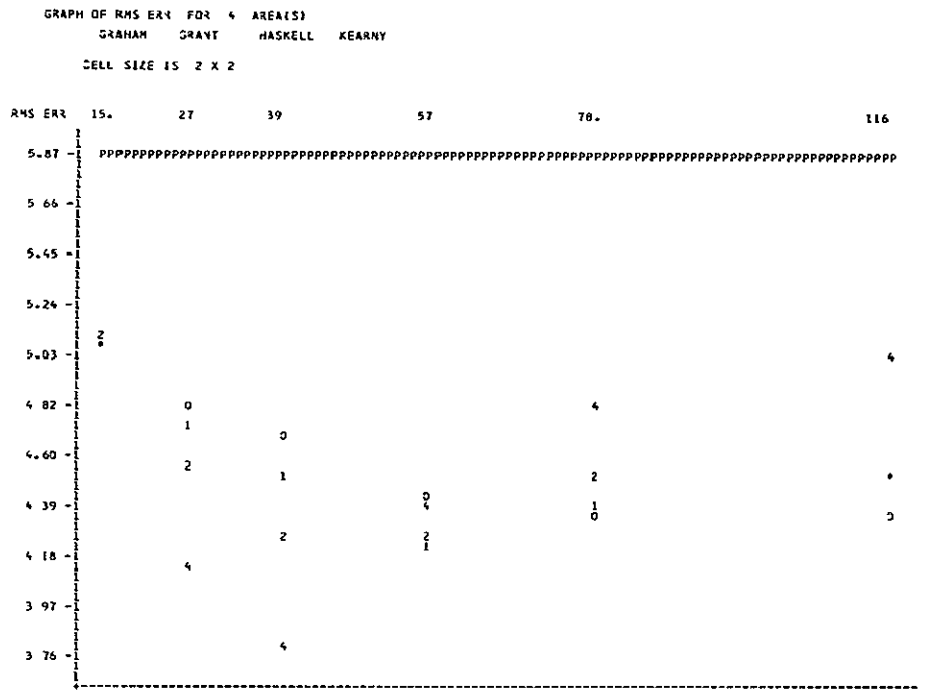


FIGURE 9

LACIE/SRS RMS PROPORTION ESTIMATION ERROR

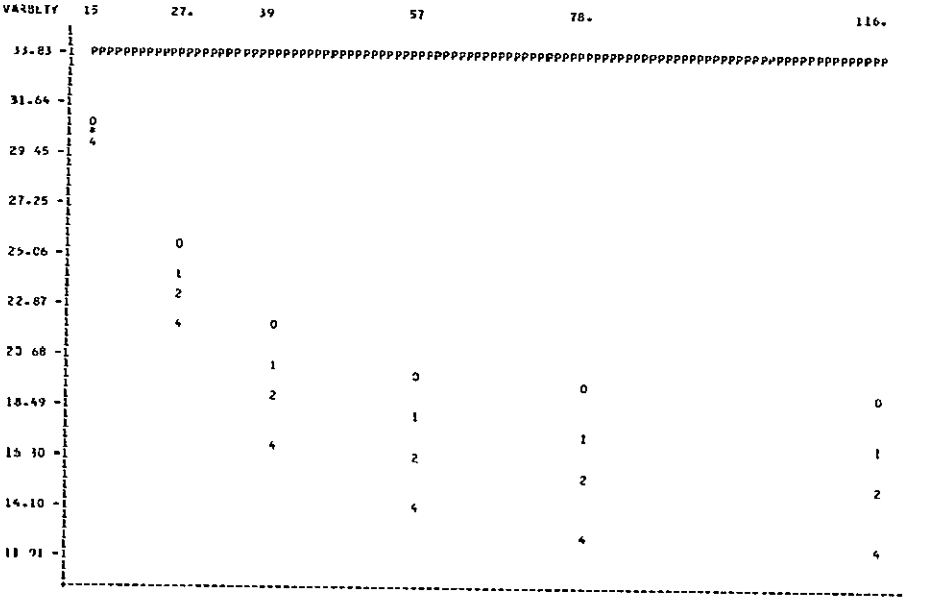


FIGURE 10

LACIE/SR CLASSIFICATION VARIABILITY

TABLE 2.1-5

EFFECT OF ECHO PARAMETERS ON INDIVIDUAL 1974 LACIE DATA SETS

ABBREVIATIONS:

CPU	CENTRAL PROCESSING UNIT TIME
FCP	FIELD CENTER PIXEL PERFORMANCE
FULL	FULL FIELD PERFORMANCE
TRAIN	TRAINING FIELD PERFORMANCE
RMS	RMS PROPORTION ERROR
VAR	CLASSFICATION VARIABILITY
CELW	CELL WIDTH
HOM	CELL HOMOGENEITY THRESHOLD
ANN	ANNEXATION THRESHOLD

ANALYSIS OF VARIANCE RESULTS (ENTRIES ARE SIGNIFICANCE LEVELS):

	CELW	HOM	ANN	CELW X HOM	CELW X ANN	HOM X ANN
Graham County, Kansas						
CPU	.1	.1	7.5	.1	24.7	99.9
FCP	.1	.1	18.7	.1	.1	18.9
FULL	.1	.1	99.9	.1	1.6	33.6
TRAIN	.1	.1	.1	.1	.1	.2
RMS	.1	.1	.1	.1	.1	99.9
VAR	.1	.1	.1	.1	.1	.1
Grant County, Kansas						
CPU	.1	.1	.8	.1	2.2	99.9
FCP	.1	.1	.1	.1	.1	99.9
FULL	.1	.1	.1	.1	.1	99.9
TRAIN	.1	.1	.1	.1	.1	34.9
RMS	.1	.1	99.9	.1	99.9	41.8
VAR	.1	.1	.1	.1	.1	40.3
Haskell County, Kansas						
CPU	.1	.1	.2	.1	.1	33.0
FCP	.1	.1	.1	.1	.1	25.5
FULL	.1	.1	.3	.1	.1	33.5
TRAIN	.1	.1	.1	.1	.1	29.5
RMS	.1	.1	.1	.1	.1	9.1
VAR	.1	.1	.1	.1	.1	27.1

TABLE 2.1-5 (Continued)

EFFECT OF ECHO PARAMETERS ON INDIVIDUAL 1974 LACIE DATA SETS

	CELW	HOM	ANN	CELW X HOM	CELW X ANN	HOM X ANN
Kearny County, Kansas						
CPU	.1	.1	.1	.1	.4	99.9
FCP	.1	.1	6.5	.1	.1	99.9
FULL	.1	.1	1.6	.1	.1	99.9
TRAIN	.1	.1	.3	.1	.1	13.0
RMS	.1	.1	.1	.1	15.3	2.0
VAR	.1	.1	.1	.1	.1	.1

Table 2.1-6

EFFECT OF ECHO PARAMETERS ON FOUR LACIE DATA SETS

	Cell Width	Cell Homogeneity Threshold	Annexation Threshold	Cell Width X Cell Homogeneity Threshold	Cell Width X Annexation Threshold	Cell Homogeneity Threshold X Annexation Threshold
Degrees of Freedom	2,6	5,15	3,9			
CPU Time		1	1	.1	99.9	99.9
Field Center Pixel Performance	5	5		.1	.4	99.9
Full Field Performance	5	1	25	.1	.6	99.9
Training Performance	10	1		.1	.1	99.9
RMS Error		25		.1	99.9	99.9
Classification Variability	5	1	1	.1	.1	13.6

Entires are Significance Levels

classifications are necessary when there are fewer cells which must be classified on a point-by-point basis (due to the increased cell homogeneity parameter), and fewer classifications are required when a scene is composed of a few large objects rather than many small objects (the effect of increasing the annexation parameter). Both of these effects are statistically significant at a 1% confidence level.

The statistical significance levels of the various ECHO parameters on each of the six dependent variables (CPU time, field center pixel performance, "full field" performance, training field performance, RMS proportion error, and classification variability) for each of the LACIE data sets are presented in Table 2.1-5. Table 2.1-6 presents the statistical significance levels of the ECHO parameters on the dependent variables for the four LACIE data sets combined.

Parameter Considerations

For the LACIE data runs, cell widths were sampled at 2, $\sqrt{\text{average field size}}/2 + 1$, and $\sqrt{\text{average fields size}}$; hence cell widths sampled were 2, 5 or 6, and 8 or 9. The field center pixel performances at the 2 by 2 cell size tended to be superior to those at 5 by 5 or 6 by 6; RMS proportion estimation errors of 2 by 2 cells were about equivalent to those of the 5 by 5 or 6 by 6 cells; and less computer time was required for the 5 by 5 or 6 by 6 sized cells than the 2 by 2 cells.

Graham County was also sampled at cell sizes 3 by 3 and 4 by 4 to observe what effects intermediate cell sizes might have. Results for the optimal values of these parameters are presented below:

Graham County, Kansas

Optimal Results

Cell Size	CPU Range (Sec)	FCP Performance %	RMS Error %
2x2	109-73	93.9	0.1
3x3	101-59	94.3	0.1
4x4	95-50	93.9	0.0
6x6	98-51	93.3	0.7
Perpoint	121	89.9	1.2

These results tend to indicate that cell width may be optimized for the LACIE/SRS runs when it is in the neighborhood of the fourth root of the average field size. This value is between three and four for Graham County.

For the 2 by 2 tests (performed on all four LACIE/SRS sites) the optimal cell homogeneity parameter, based on the three fields performance criteria, appears to be 78. However, on the basis of RMS error, the optimal homogeneity parameter tested is 39.

Due to the two pixel inset used to avoid mixture pixels and registration error for the LACIE/SRS field coordinates, small fields were not used for training or test purposes. Since only relatively large fields are included in the training decks, the effects that increasing the cell homogeneity parameter may have on the small fields is not reflected in the field center pixel performance results. Consequently, for the LACIE results, 39 is probably closer to the optimal homogeneity parameter than 78. Support for this conclusion is provided by the results in Figure 8. The "full field" performance measures the performance of the large test fields, including the points which contain the field boundaries. "Full field" test fields are composed of the pixels contained in the field center pixel test fields

plus those pixels on the borders of the field ("fringe pixels"). Since for the LACIE data sets, the performance of the field center pixels improves by .5% between cell homogeneity values 39 and 78 while the full field performance only improved by .2%, it would appear that the performance of the "fringe pixels" is degraded between homogeneity parameters 39 and 78. Those small fields not included in the test decks will be composed primarily of "fringe pixels".

It can be noted by examining Figures 6 through 9 that the effect of annexation increases as the cell homogeneity parameter increases. This result is expected since a cell A only has the opportunity to be annexed to adjoining cell B when both cells A and B are homogeneous. The higher the cell homogeneity parameter, the more likely it becomes that both A and B will be homogeneous.

Figure 10 is typical of all the variability results: as the homogeneity and annexation parameters increase, the classification variability decreases.

LACIE/SRS Conclusions

1. CPU time and classification variablity decrease as cell homogeneity and cell to field annexation parameters increase (1% significance level).

2. The optimal cell width parameter may fall between two and average field size/2 + 1. The fourth root of the average field size may be an appropriate value.

3. For these data sets, the optimal annexation value appears to be in the neighborhood of two based on field center pixel and full field performances.

4. For a cell width of two, the optimal cell homogeneity parameter is in the neighborhood of 39, based on RMS proportion estimate error.

ii. CITARS Results

Figures 11 through 16 present plots for the 2 by 2 cell size Supervised ECHO results achieved from the CITARS data sets. Characteristic differences between the CITARS and the LACIE/SRS data sets include:

* The CITARS data set has a much smaller average field size than the LACIE/SRS set.
* The information classes are different. CITARS information classes are Corn, Soybeans and Other; LACIE/SRS classes are Wheat and Other.
* The ground truth proportion estimates used for the LACIE/SRS sites were for the area of the LACIE segment. The ground truth proportion estimates used for the CITARS sites are for the whole county in which the data set lies, not for that area of the county which was actually sampled.

Analysis of variance results for the six CITARS data sets are presented in Tables 2.1-7 and 2.1-8. Table 2.1-7 presents results for each data set individually. Table 2.1-8 presents the analysis of variance results for the combined CITARS data sets.

As with the 1974 LACIE/SRS data sets, the CPU time decreased as cell homogeneity and annexation parameters increase.

However, though Figure 5 (CPU time for the LACIE/SRS data set) and Figure 11 (CITARS CPU time) have the same general shape, there is one important difference: the CPU time required to perform the ECHO classification is a higher percentage of the CPU time required to perform the perpoint classification for each cell homogeneity value. This is a reflection of the smaller field size in the CITARS data set. Since fields are smaller, more boundaries and fewer homogeneous cells exist. As a result, more cells must be classified on a point-by-point basis and more CPU time

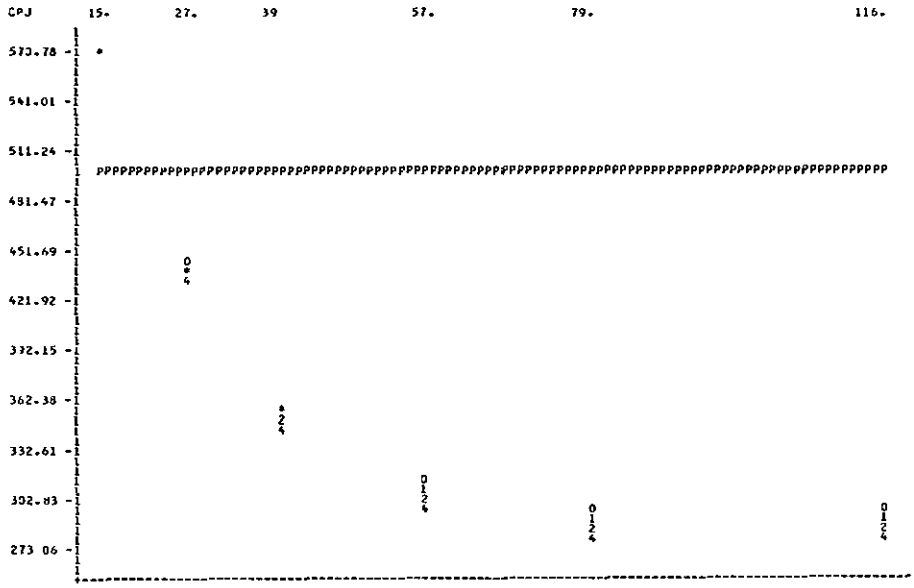


FIGURE 11

CITARS CPU TIMES

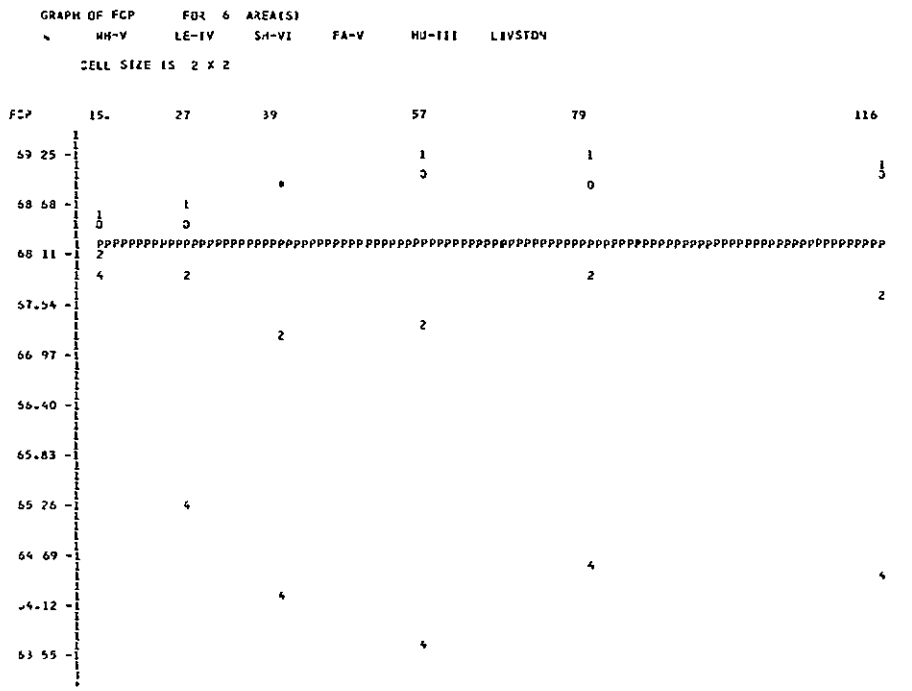


FIGURE 1

CITARS FIELD CENTER LIGHT TEMPERATURE

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

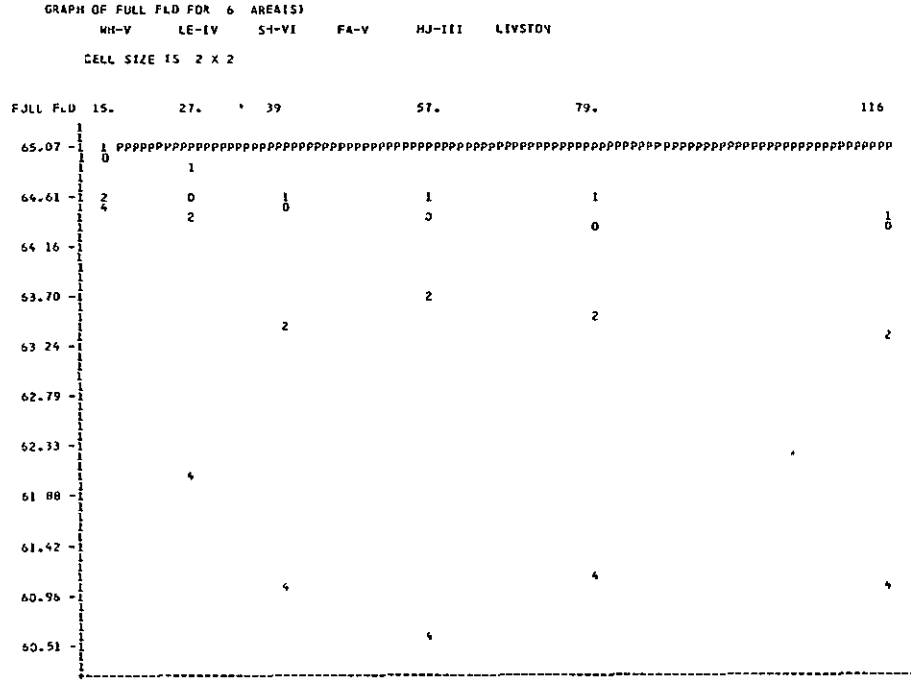


FIGURE 13

CITARS FULL FIELD PERFORMANCE

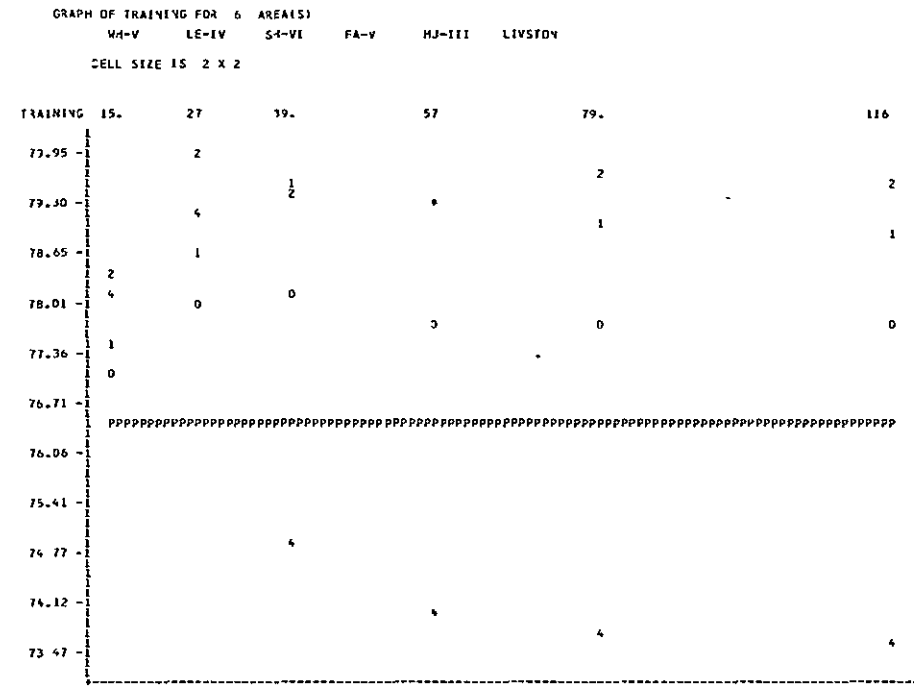


FIGURE 14

CITARS TRAINING ACCURACY

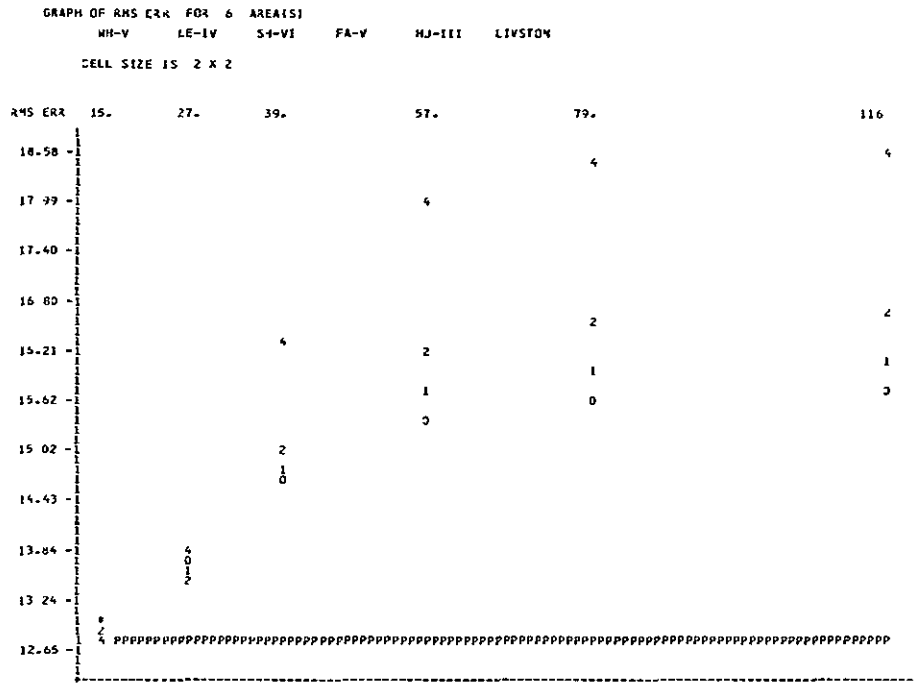


FIGURE 15

CITARS RMS PROPORTION ESTIMATE ERROR

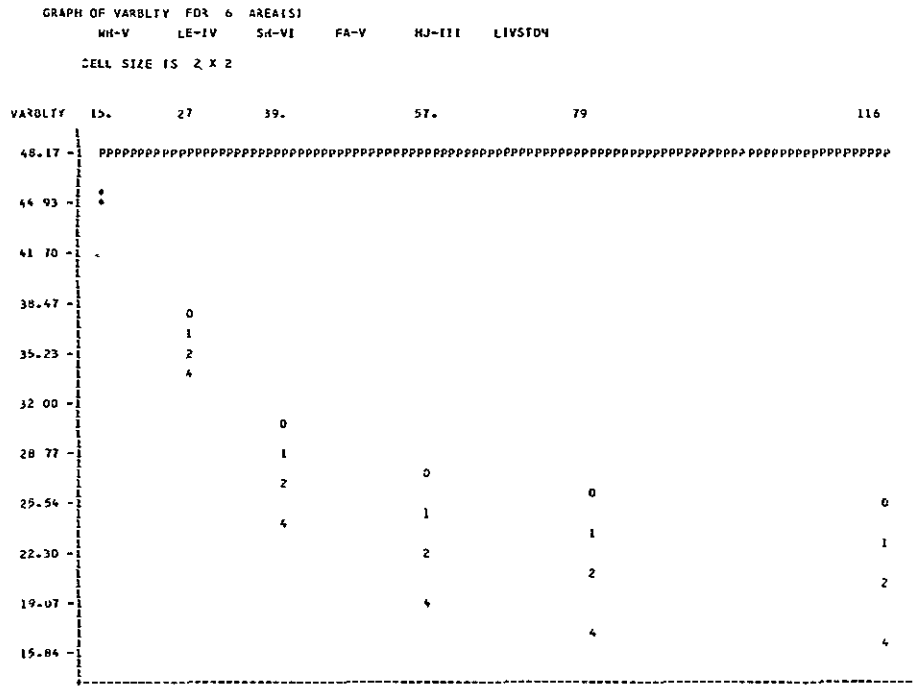


FIGURE 16

CITARS CLASSIFICATION VARIABILITY

TABLE 2.1-7

EFFECT OF ECHO PARAMETERS ON INDIVIDUAL CITARS DATA SETS

ABBREVIATIONS:

CPU	CENTRAL PROCESSING UNIT (COMPUTER) TIME
FCP	FIELD CENTER PIXEL PERFORMANCE
FULL	FULL FIELD PERFORMANCE
TRAIN	TRAINING FIELD PERFORMANCE
RMS	RMS PROPORTION ESTIMATE ERROR
VAR	CLASSIFICATION VARIABILITY
CELW	CELL WIDTH
HOM	CELL HOMOGENEITY THRESHOLD
ANN	ANNEXATION THRESHOLD

ANALYSIS OF VARIANCE RESULTS (ENTRIES ARE SIGNIFICANCE LEVELS):

	CELW	HOM	ANN	CELW X HOM	CELW X ANN	HOM X ANN
Huntington County, Indiana						
CPU	.1	.1	.1	.1	.1	12.7
FCP	.7	.1	99.9	.1	.3	5.9
FULL	37.4	.1	37.1	.1	1.3	20.6
TRAIN	.1	.1	.1	.1	.1	12.9
RMS	.1	.1	99.9	.1	32.7	39.2
VAR	.1	.1	.1	.1	.1	.1
Shelby County, Indiana						
CPU	.1	.1	.1	.1	.1	44.7
FCP	.1	.1	.1	.1	.1	.1
FULL	.1	.1	.1	.1	.1	.1
TRAIN	.1	.4	.1	27.2	.1	.8
RMS	.1	.1	.1	.1	.1	.1
VAR	.1	.1	.1	.1	.1	.1
White County, Indiana						
CPU	.1	.1	.1	.1	.4	99.9
FCP	.1	.1	.1	.1	.1	99.9
FULL	.1	.1	.1	.1	.1	22.8
TRAIN	.1	.1	.1	.1	.1	99.9
RMS	.1	.1	.1	.1	.1	43.1
VAR	.1	.1	.1	1 .1	.1	.2

TABLE 2.1-7 (Continued)

EFFECT OF ECHO PARAMETERS ON INDIVIDUAL CITARS DATA SETS

	CELW	HOM	ANN	CELW X HOM	CELW X ANN	HOM X ANN
Livingston County, Illinois						
CPU	.1	.1	.1	.1	.1	23.0
FCP	.1	14.8	.1	.1	.1	22.1
FULL	.1	.1	.1	.1	.1	3.2
TRAIN	.1	.1	.1	.1	.1	18.7
RMS	.1	.1	.1	.1	1.8	12.9
VAR	.1	.1	.1	.1	.1	.1
Fayette County, Illinois						
CPU	.1	.1	1.1	.1	3.2	99.9
FCP	.1	.1	.1	.1	.1	17.8
FULL	.1	.1	.1	.1	1.8	17.1
TRAIN	.1	.1	2.9	12.6	.4	99.9
RMS	.1	.1	.1	.1	.1	.1
VAR	.1	.1	.1	.1	.1	.3
Lee County, Illinois						
CPU	.1	.1	.1	.1	.1	17.3
FCP	.1	.1	34.9	39.4	.1	99.9
FULL	.1	.1	99.9	7.5	.1	99.9
TRAIN	.1	.1	.1	.1	.2	11.0
RMS	.2	.1	.1	.1	.1	.1
VAR	.1	.1	.1	.1	.1	1.8

Table 2.1-8

EFFECT OF ECHO PARAMETERS ON SIX CITARS DATA SETS

	Cell Width	Cell Homogeneity Threshold	Annexation Threshold	Cell Width X Cell Homogeneity Threshold	Cell Width X Annexation Threshold	Cell Homogeneity Threshold X Annexation Threshold
Degrees of Freedom	2,10	5,25	3,15			
CPU Time	1	1	1	.1	19.3	99.9
Field Center Pixel Performance	10	10	25	.1	.1	34.1
Full Field Performance	10	5	25	.1	.1	99.9
Training Performance	1	1	25	.1	.1	12.0
RMS Error	99	10	25	.1	.1	28.2
Classification Variability	1	1	1	.1	.1	.1

Entries are Significance Levels

is required to perform those point-by-point classifications. For the smallest cell homogeneity parameter, ECHO takes more time on the average than the perpoint classifier. This is due to a great majority of the cells being split. For a cell that is split, the ECHO processor must first gather statistics and perform the homogeneity test, at some expense in CPU time. Then each point of the singular cell must be classified on a point-by-point basis which takes approximately the same CPU time as the perpoint classifier. Hence, when the great majority of cells are singular, ECHO is less efficient, in terms of CPU time, than the perpoint classifier.

By examining the CITARS field center pixel performance (Figure 12) in light of the LACIE/SRS results, two conclusions can be drawn:

1. The improvement in classification accuracy the ECHO procedure provides is reduced for the CITARS data sets, as compared to the LACIE set.

2. The optimal annexation parameter is smaller for the CITARS data sets than for the LACIE data sets.

It is evident by comparing Figures 12 and 14, that the CITARS training set is not representative of the test fields for the ECHO data sets. The performance of the training fields using ECHO is markedly superior to the performance of those same fields using the perpoint classifier. However, the field center pixel performance of the ECHO algorithm is only marginally superior in magnitude to the performance of the perpoint classifier. This indicates that on the data which the statistics truly represent, ECHO performance is superior; when the first and second order statistics fail to properly represent the classes, especially in areas with small field sizes, ECHO's performance may be no better than that of the perpoint classifier.

The average RMS error achieved by ECHO for the six CITARS data sets is inferior to the average RMS error achieved by the perpoint classifier using the same class statistics. On a flightline by flightline basis,

ECHO's RMS proportion estimate error was higher than the perpoint RMS error for three of the data sets and lower than the perpoint RMS error for the other three data sets. This may be partially due to one or more of the following:

* The RMS error values are generally high. The proportion estimates used for "truth" are the SRS estimates for the counties as a whole, not for the individual areas classified. Hence, if an area classified is not a good approximation of the county as a whole, the validity of the RMS results must be questioned.
* The training fields do not appear to be a good representation of the test fields. If the training statistics do not represent the scene as a whole, ECHO performance may suffer to a greater extent than the perpoint performance.
* When the average field size is small, there will be a high proportion of "mixture" cells (cells containing points of more than one class). Should a cell containing pixels of differing classes pass the homogeneity criteria, it is likely to be categorized into the class with the highest variance. Thus as the cell homogeneity criteria becomes larger, the RMS error would tend to increase. (An observed result - see Figure 15.)

The effect of cell width on RMS error was not significant when all the CITARS data sets are considered at once. However, cell width produced significantly different results in terms of RMS error for each of the six data sets taken individually. The effects of increasing cell width were opposite for different data sets.

Conclusions

* As the field size becomes smaller, the improvement in classification accuracy provided by the supervised ECHO algorithm is reduced. At the same time, due to the increased number of singular cells, the CPU time which Supervised ECHO requires increases.

* When the training set is representative of the data, ECHO's classification performance continues to be superior to that of the per-point classifier for scenes with average fields at or below 16 to 20 pixels.

* Due to the mixture-cell, large-variance-class problem, ECHO may or may not degrade RMS proportion Estimation for areas with relatively small fields.

iii. Bitemporal Results

Figures 17 through 22 illustrate the Supervised ECHO results for the Bitemporal analysis. Figures 17a through 22a are the results of a unitemporal analysis of the same area. The training for the bitemporal analysis was done independently of the training for the unitemporal analysis. Comparing Figures 18 and 18a it can be seen that the ECHO field center pixel performance is a greater improvement over the perpoint classifer's performance in the unitemporal case. This may partially be a result of some misregistration between dates making object extraction more difficult and partially a function of the different training statistics used for the separate classifications.

With the larger number of channels in the multidate classification, the optimal homogeneity threshold is higher than it would be for the single date classification. This is expected as, for the Supervised algorithm, the homogeneity criteria approximates to a chi-squared statistic with (number of channels) times (cell width squared) degrees of freedom. For the same significance level of test, the cell homogeneity criteria should be higher for the eight channel data than for the four channel data.

Based on the field center pixel performance and the RMS proportion error results, the optimal settings of the homogeneity and annexation parameters appear to be in the neighborhood of 180 and 1, respectively.

Note that although the multitemporal analysis does not greatly improve the field center pixel classification accuracy, it does (especially for the perpoint classifier) substantially reduce the RMS proportion estimate error. In the Bitemporal analysis the perpoint RMS error is only .2%, leaving ECHO little room for improvement. Note also that for several ECHO parameter settings in the unitemporal analysis, ECHO performs with an RMS

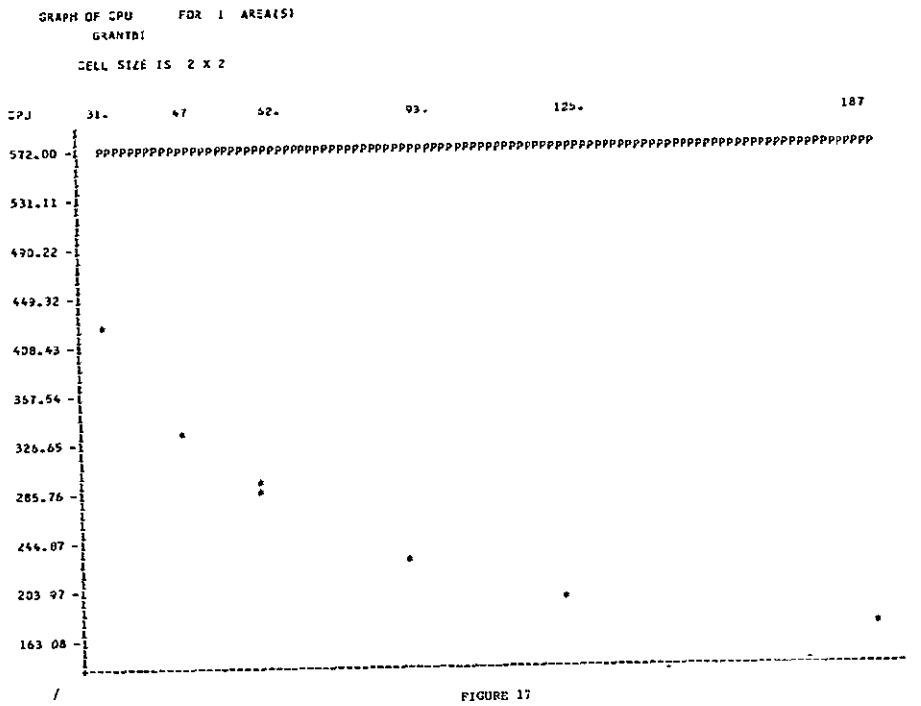


FIGURE 17

GRANT COUNTY BITEMPORAL CPU TIMES

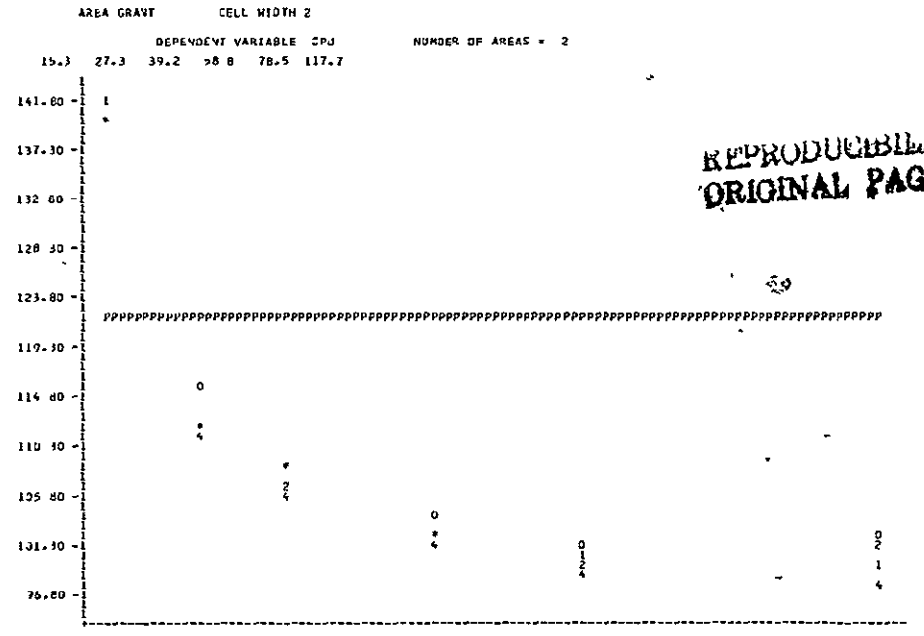


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FIGURE 17a

GRANT COUNTY UNITEMPORAL CPU TIMES

FIGURE 18

GRANT COUNTY BITEMPORAL FIELD CENTER PIXEL PERFORMANCE

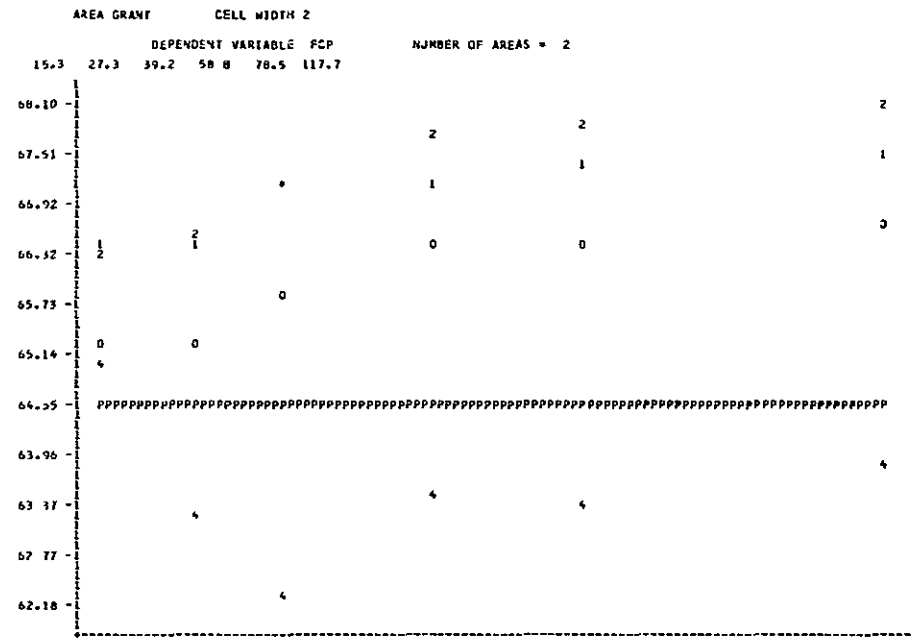

FIGURE 18a

GRANT COUNTY UNITEMPORAL FIELD CENTER PIXEL PERFORMANCE

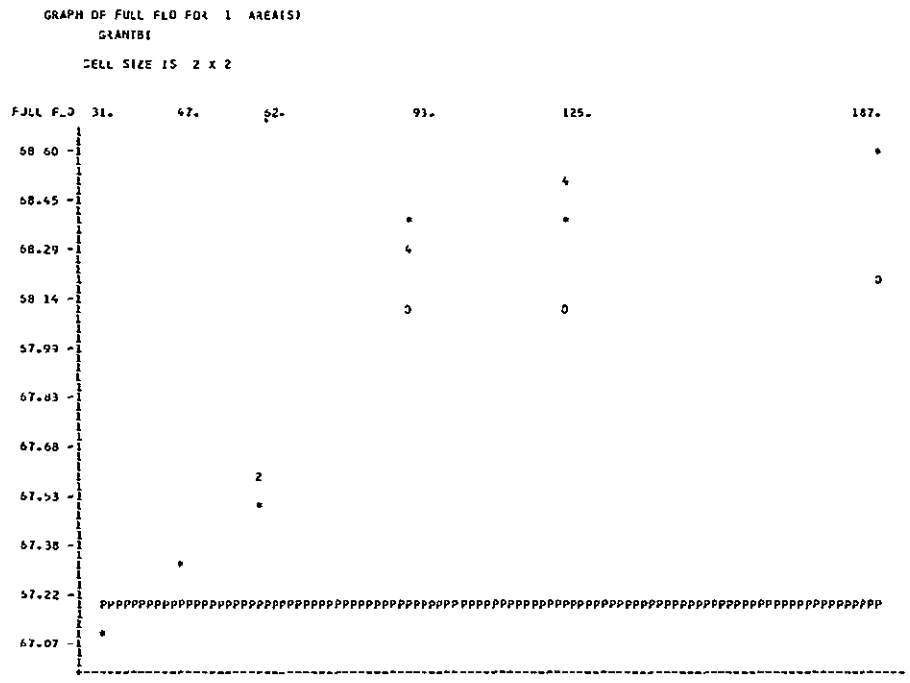

FIGURE 19

GRANT COUNTY BITEMPORAL FULL FIELD PERFORMANCE

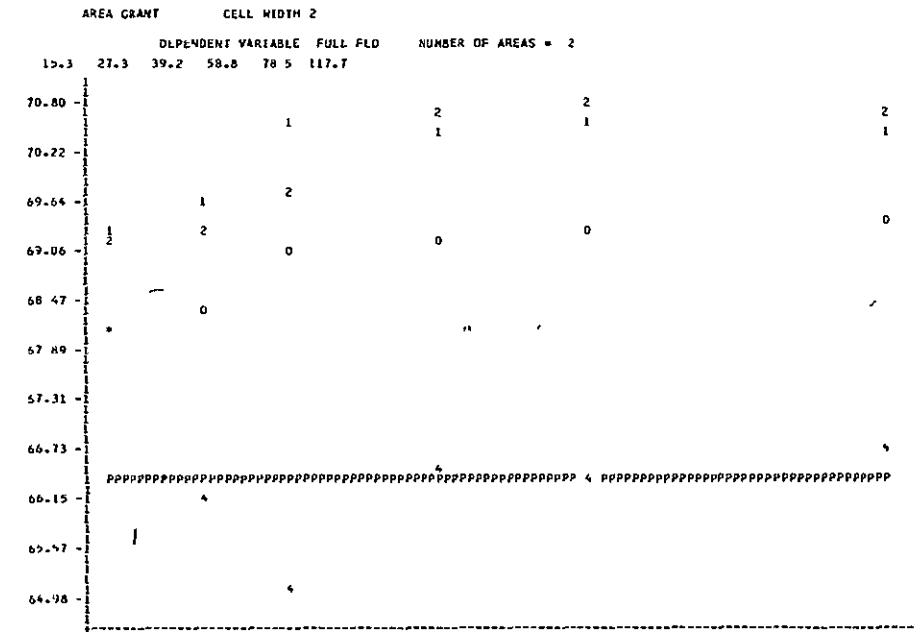

FIGURE 19a

GRANT COUNTY UNITEMPORAL FULL FIELD PERFORMANCE

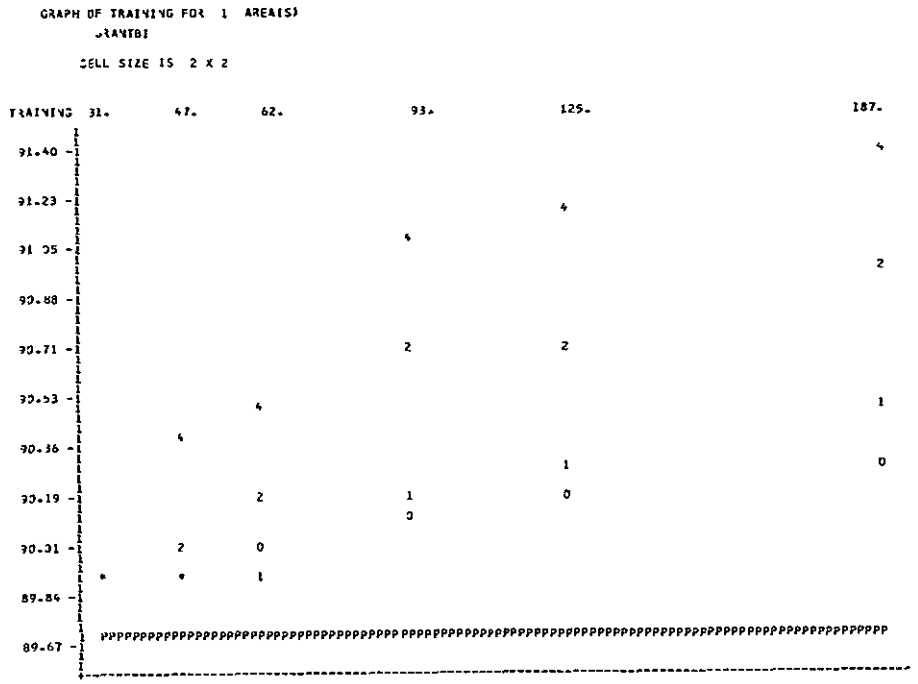

FIGURE 20

GRANT COUNTY BITEMPORAL TRAINING FIELD PERFORMANCE

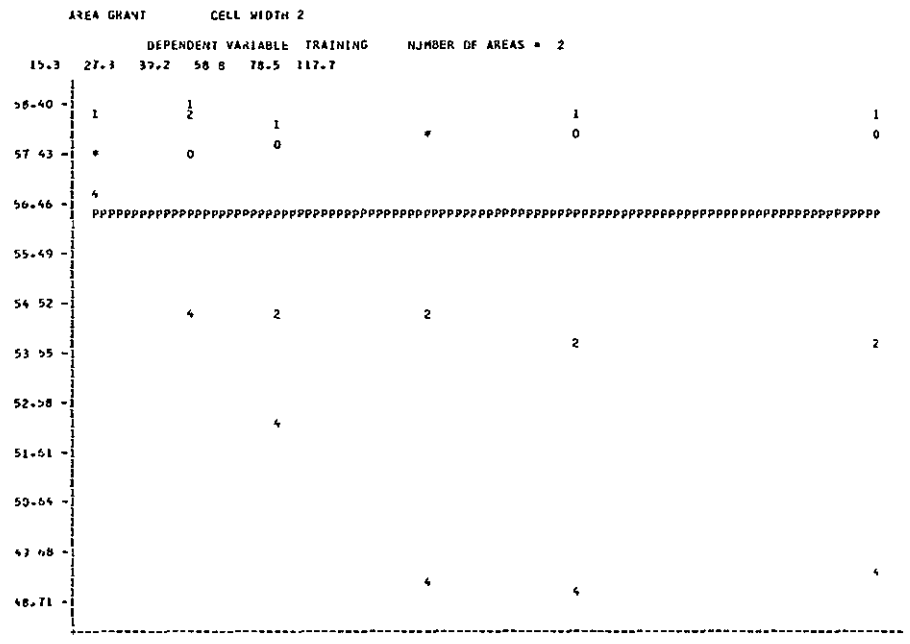

FIGURE 20a

GRANT COUNTY UNITEMPORAL TRAINING FIELD PERFORMANCE

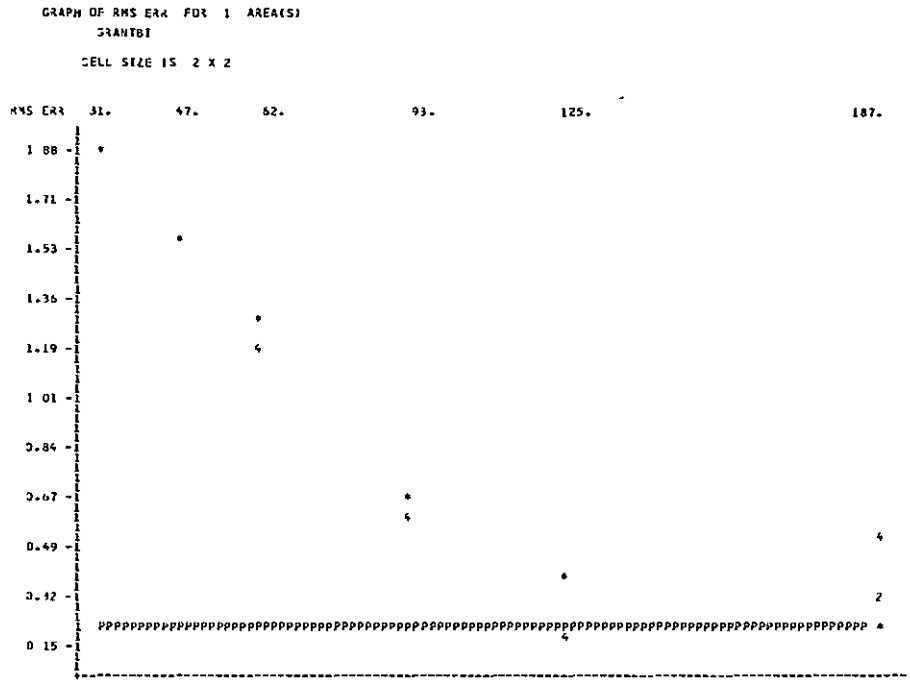

FIGURE 21

GRANT COUNTY BITEMPORAL RMS PROPORTION ESTIMATE ERROR

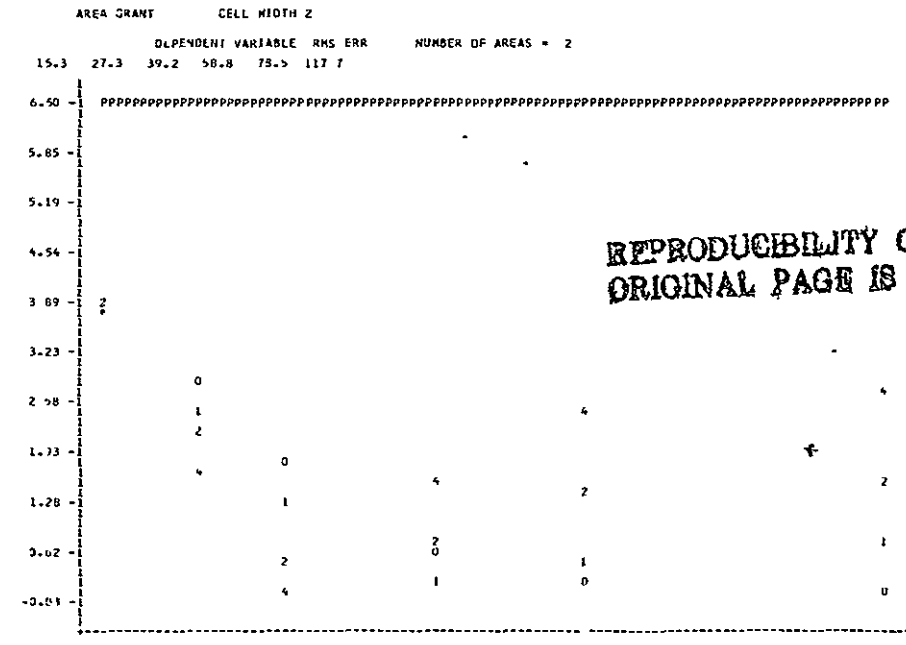

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FIGURE 21a

GRANT COUNTY UNITEMPORAL RMS PROPORTION ESTIMATE ERROR

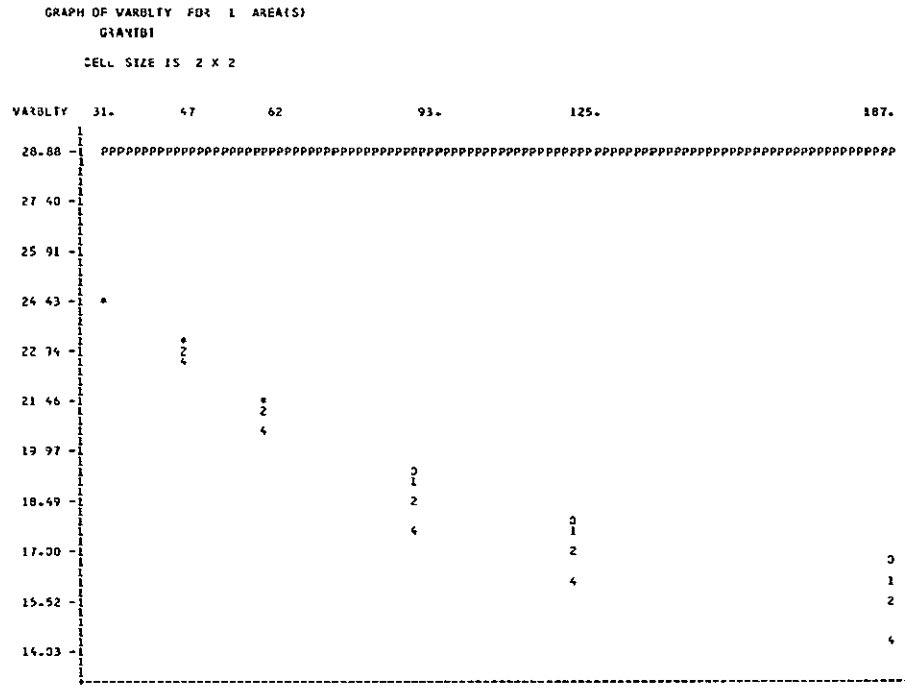

FIGURE 22

GRANT COUNTY BITEMPORAL CLASSIFICATION VARIABILITY

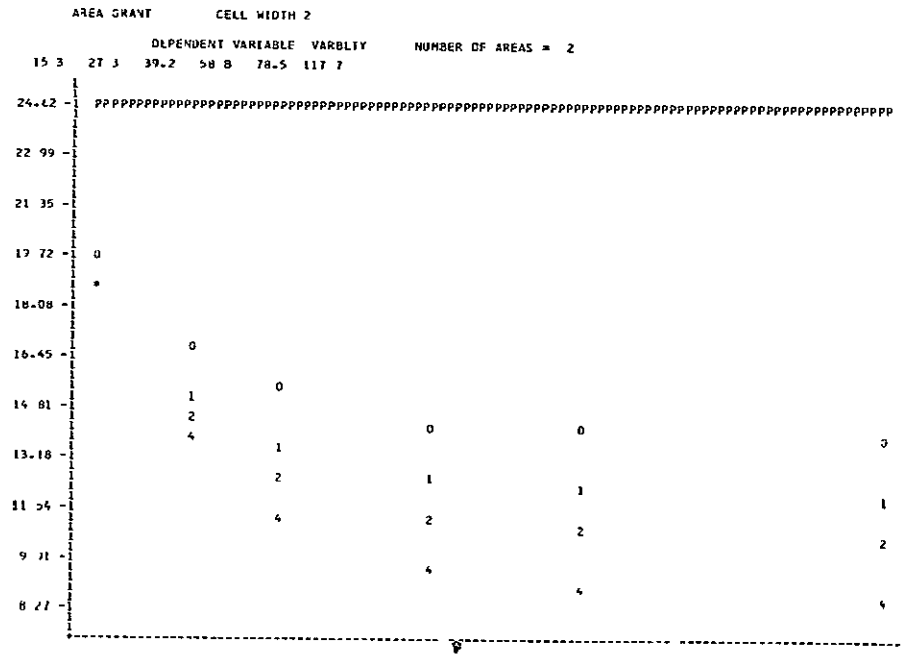

FIGURE 22a

GRANT COUNTY UNITEMPORAL CLASSIFICATION VARIABILITY

proportion estimate error of under .5% while the perpoint classifier is functioning with a 6.5% RMS error.

In the multitemporal case, ECHO requires less CPU time than the perpoint classifier for all parameter settings. This is not true in the unitemporal case.

Bitemporal Conclusions

* The Supervised ECHO processor produced classifications superior to those produced by the perpoint classifier in terms of CPU time and field center pixel accuracy for the frame analyzed.

* The optimal homogeneity parameter for bitemporal analysis appears to be much larger than for the unitemporal case.

* The CPU time required and classification variability produced by ECHO are smaller than those of the perpoint classifier.

iv. Overall LANDSAT Results

Table 2.1-9 summarizes the effects of the ECHO parameter settings on the six dependent variables. Figures 23 through 28 plot the average ECHO performance at the various ECHO parameter settings versus the average perpoint performance for the ten LANDSAT data sets.

The cell width setting effects are significant for all dependent variables for all LANDSAT data sets considered individually, and are significant for all dependent variables except RMS proportion error when all LANDSAT data sets are considered together, using data sets as blocks.

When the LACIE and CITARS LANDSAT runs are considered separately, cell width is significant for CPU time, training performance, and classification variability for the CITARS data sets and for CPU time, field center pixel performance, "full field" performance, and classification variability in the LACIE data sets.

The statistically significant (5% significance level) overall cell width effects for the LANDSAT data sets are:

- As cell width increases, CPU time decreases.
- As cell width increases, field center pixel, "full field" and training field performances decrease.
- As cell width increases, classification variability decreases.

Though not statistically significant, the trend is for RMS error to increase as cell width increases. Two things should be noted about the cell width overall results:

* It is not uniformly true that all cell width increases, field center pixel, "full field" and training field performances decrease.

Table 2.1-9

EFFECT OF ECHO PARAMETERS ON SIX VARIABLES USING DATA SET AS A BLOCK (ALL TEN LANDSAT DATA SETS)

	Cell Width	Cell Homogeneity Threshold	Annexation Threshold	Cell Width X Cell Homogeneity Threshold	Cell Width X Annexation Threshold	Cell Homogeneity Threshold X Annexation Threshold
Degrees of Freedom	2,18	5,45	3,27			
CPU Time	5	1	1	.1	99.9	99.9
Field Center Pixel Performance	1	1	25	.1	.1	31.5
Full Field Performance	1	1	25	.1	.1	99.9
Training Performance	1	1	10	.1	.1	1.1
RMS Error	25	10	25	.1	3.2	99.9
Classification Variability	1	1	1	.1	.1	.1

Entries are Significance Levels

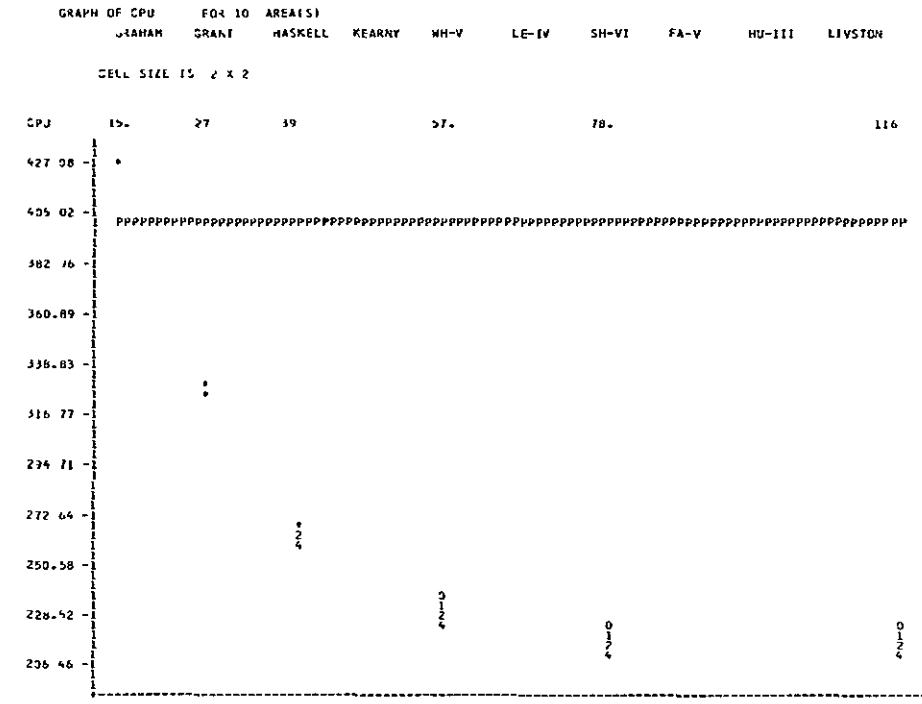

FIGURE 23

LANDSAT CPU TIMES

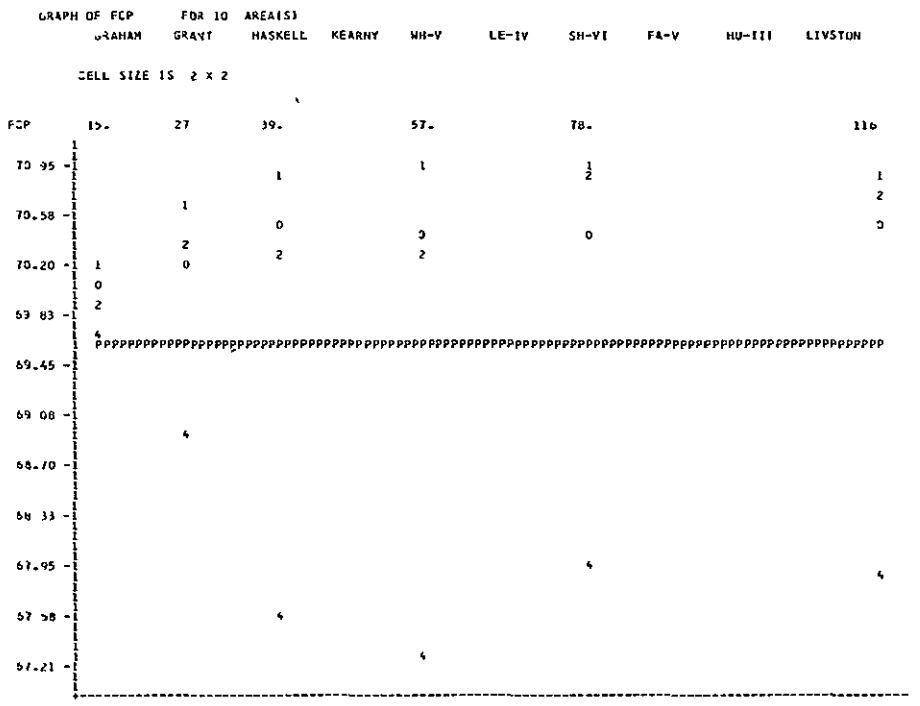

FIGURE 24

LANDSAT FIELD CENTER PIXEL PERFORMANCE

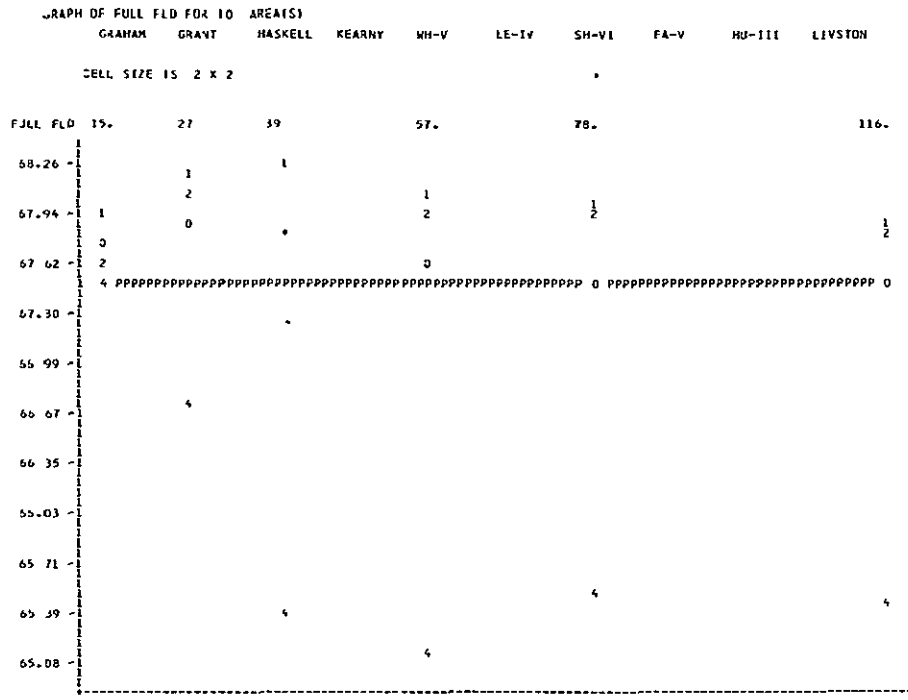

FIGURE 25

LANDSAT FULL FIELD PERFORMANCE

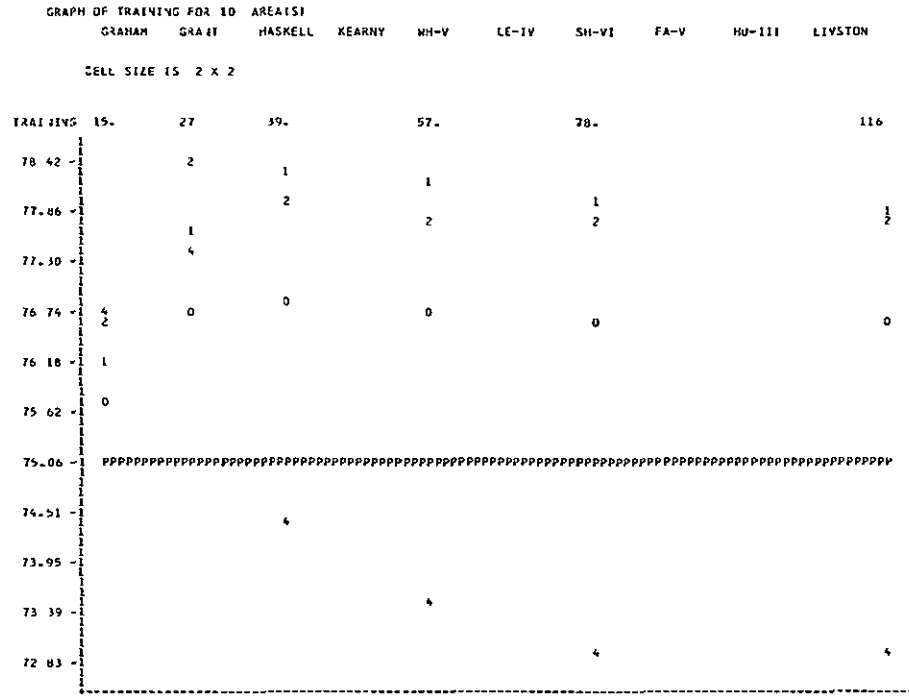

FIGURE 26

LANDSAT TRAINING FIELD PERFORMANCE

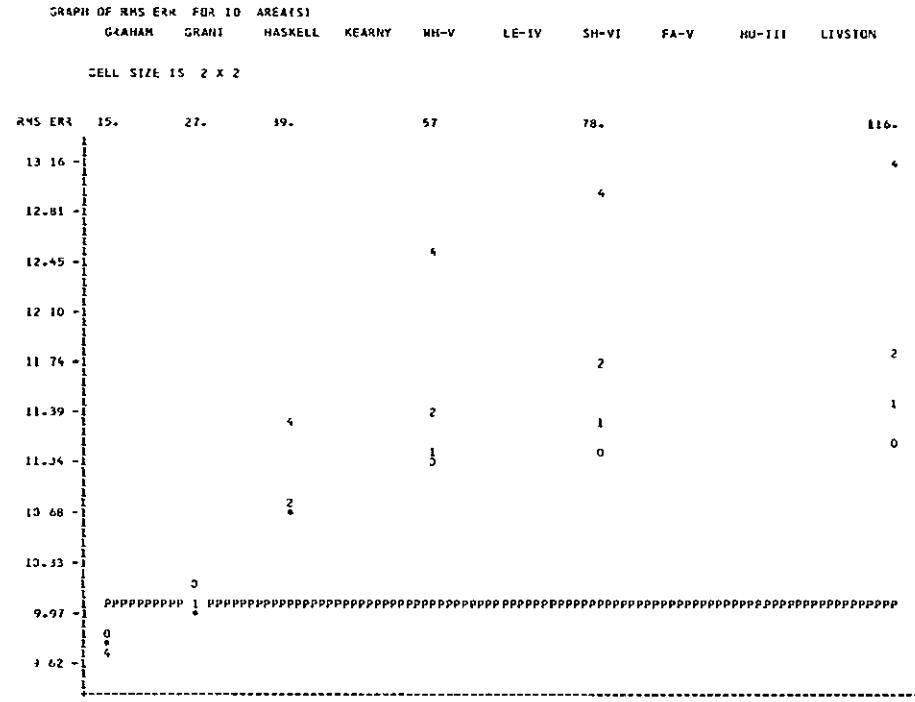

FIGURE 27

LANDSAT RMS PROPORTION ESTIMATE ERRORS

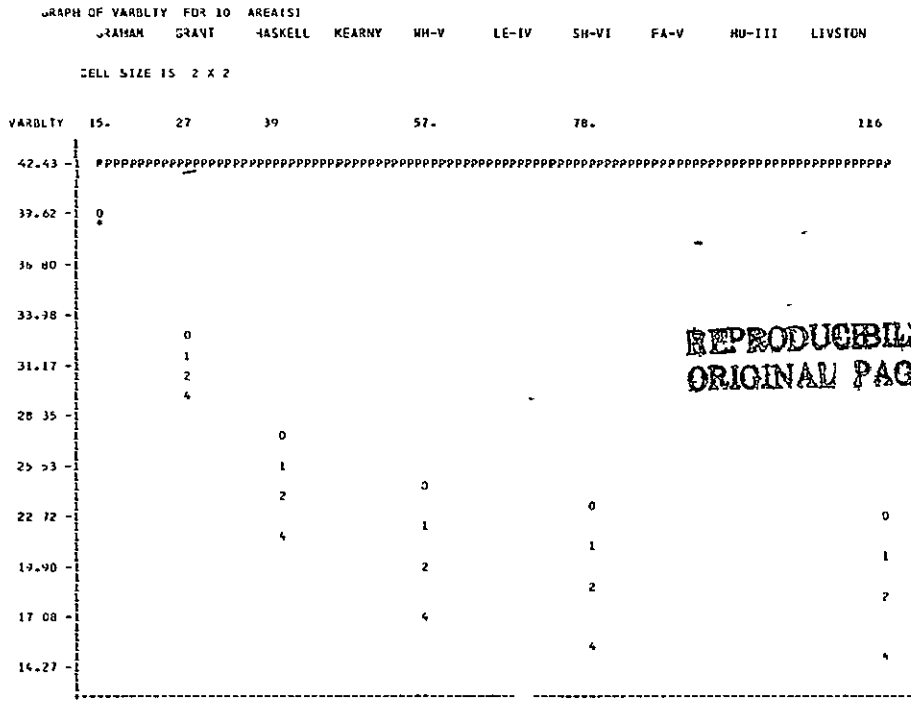

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FIGURE 28

LANDSAT CLASSIFICATION VARIABILITY

* Since not all cell widths were sampled between two and the $\sqrt{\text{average field size}}/2 + 1$, it may be true that the optimal cell width for a data set lies between these two parameters. Indications from the Graham County analysis are that the optimal cell width may be in the neighborhood of the fourth root of the average field size.

The cell homogeneity threshold is significant for all dependent variables both when all LANDSAT data sets are considered individually and when all LANDSAT data sets are considered together.

The cell homogeneity threshold is significant for CPU time, "full field" performance, training performance, and classification variability for the combined CITARS data sets and is significant for CPU time, field center pixel performance, "full field" performance, training performance and classification variability in the combined LACIE data sets.

The statistically significant overall effects of the cell homogeneity parameter are:

- As the homogeneity parameter increases, CPU time and variability decrease.
- As the homogeneity parameter increases, field center pixel, "full field" and training performances decrease. Figures 24 through 26 indicate, however, that for the first two or three homogeneity threshold values, as the homogeneity threshold increases, the performances also increase.

As the homogeneity parameter increases, RMS error shows a trend towards increasing (Figure 27) though this trend is not significant at a 5% confidence level.

The annexation parameter is significant in 86% of the 60 cases in the LANDSAT data sets. It is significant only for CPU time and classification variability when the CITARS or the LACIE or all the LANDSAT data sets are

considered together. This indicates that the proper annexation parameter is highly data dependent. As the annexation threshold increases, CPU time and classification variability tend to decrease.

The interaction of cell width and the cell homogeneity threshold is significant in 95% of the 60 cases of 6 dependent variables and 10 LANDSAT data sets. This interaction is significant for all dependent variables when the CITARS or the LACIE or all LANDSAT data sets are considered together.

The interaction of cell width and annexation parameter is significant in 93% of the 60 LANDSAT cases. When all the LANDSAT data sets are considered together, the cell width-annexation interaction is significant for all dependent variables except CPU time. This is also true for the CITARS data sets. However, for the LACIE data sets, the interaction is not significant for RMS proportion error.

The cell homogeneity-annexation interaction was significant in 30% of the 60 individual LANDSAT data set ANOVAs, being significant in 90% of the data sets for variability and 50% of the data sets for RMS proportion error. When the 10 LANDSAT data sets are considered together, the cell homogeneity-annexation interaction is significant for training performance and variability. When considering only the CITARS or only the LACIE data sets, the interaction is significant for variability alone.

ECHO-Perpoint LANDSAT Comparison

When the optimal parameter setting for each dependent variable was selected from the ECHO results and compared to the perpoint results for the 10 LANDSAT data sets the following results were obtained:

- ECHO was faster than the perpoint classifier (.1% confidence level).
- ECHO's field center pixel, "full field", and training field performances were superior to those of the perpoint classifier (1.3, 5.7, .1% confidence levels, respectively).
- ECHO had a lower RMS proportion estimate error (4.4% confidence level).
- ECHO had less classification variability than the perpoint classifier (.1% confidence level).

b. Simulated Thematic Mapper Results

The analyses of variance for the effects of the ECHO parameters on the eight simulated Thematic Mapper data sets (two sites, four resolutions) are presented in Table 2.1-10. Results for the eight data sets considered together are presented in Table 2.1-11.

Cell width is significant for all dependent variables and all Thematic Mapper data sets individually. When the Thematic Mapper data sets are considered together, using site as a block and resolution as a fixed factor, cell width is significant only for training performance and classification variability. As cell width increases, classification variability decreases. As cell width increases, training performance decreases. Trends which can be noted, but which are not statistically significant at the sample size used include: as cell width increases, CPU time, field center pixel performance, and "full field" performance decrease. It may be true that a cell width between two and the square root of the average field size divided by two would be superior to those cell sizes tested in terms of CPU time, RMS error, and field center pixel, "full field" and training field performances.

The cell homogeneity parameter is significant for all dependent variables in all Thematic Mapper data sets individually. When the data sets are considered together, the cell homogeneity parameter is significant for CPU time, "full field" performance, training performance and variability. As the cell homogeneity parameter increases, the CPU time and classification variability decreases (1% significance level). "Full field" and training field performance decrease over the range of homogeneity threshold tested (1% confidence level). The graph indicates that RMS proportion error increases as the cell homogeneity criteria increases. However, this is not a consistent trend in the eight data sets and is not statistically significant.

TABLE 2.1-10

EFFECT OF ECHO PARAMETERS ON INDIVIDUAL SIMULATED THEMATIC MAPPER DATA SETS

ABBREVIATIONS:

CPU	CENTRAL PROCESSING UNIT (COMPUTER) TIME
FCP	FIELD CENTER PIXEL PERFORMANCE
FULL	FULL FIELD PERFORMANCE
TRAIN	TRAINING FIELD PERFORMANCE
RMS	RMS PROPORTION ERROR
VAR	CLASSIFICATION VARIABILITY
CELW	CELL WIDTH
HOM	CELL HOMOGENEITY THRESHOLD
ANN	ANNEXATION THRESHOLD

	CELW	HOM	ANN	CELW X HOM	CELW X ANN	HOM X ANN
Williams County, North Dakota - 30 meter resolution						
CPU	.1	.1	99.9	.1	99.9	31.8
FCP	.1	.1	.1	.1	.1	20.5
FULL	.1	.1	.1	.1	.1	28.7
TRAIN	.1	.1	4.9	.1	2.3	99.9
RMS	.1	1.0	4.4	.1	4.1	44.7
VAR	.1	.1	.1	.1	.1	46.3
Williams County, North Dakota - 40 meter resolution						
CPU	.1	.1	99.9	1.6	99.9	99.9
FCP	.1	.1	.1	.1	.1	99.9
FULL	1.9	.1	8.9	.1	3.0	40.5
TRAIN	.1	.1	99.9	.1	99.9	99.9
RMS	.1	.1	99.9	.1	99.9	27.1
VAR	.1	.1	99.9	.5	99.9	46.0
Williams County, North Dakota - 50 meter resolution						
CPU	.1	.1	99.9	.1	99.9	99.9
FCP	.1	.1	99.9	.1	9.1	99.9
FULL	.1	.1	99.9	.1	36.3	99.9
TRAIN	.1	.1	5.6	.1	42.7	34.2
RMS	.1	.1	.1	.1	.8	.1
VAR	.1	.1	.1	.1	.1	15.5

TABLE 2.1-10 (Continued)

EFFECT OF ECHO PARAMETERS ON INDIVIDUAL SIMULATED THEMATIC MAPPER DATA SETS

	CELW	HOM	ANN	CELW X HOM	CELW X ANN	HOM X ANN
Williams County, North Dakota - 60 meter resolution						
CPU	.1	.1	99.9	.1	99.9	99.9
FCP	.1	.1	19.8	.1	8.7	99.9
FULL	.1	.1	2.1	.1	.7	99.9
TRAIN	.1	.1	14.6	.1	99.9	99.9
RMS	.3	.1	99.9	9.2	26.4	99.9
VAR	.1	.1	.1	.1	.1	11.6
Finney County, Kansas - 30 meter resolution						
CPU	.1	.1	39.7	.1	15.0	3.4
FCP	.1	.1	.1	.1	.1	29.4
FULL	.1	.1	.1	.1	.1	38.6
TRAIN	.1	.1	.1	.1	.1	99.9
RMS	.1	.1	16.7	.1	44.4	24.9
VAR	.1	.1	.1	.1	.1	37.5
Finney County, Kansas - 40 meter resolution						
CPU	.1	.1	10.4	.1	1.5	9.4
FCP	.1	.1	.1	.1	.1	46.2
FULL	.1	.1	.1	.1	.1	47.4
TRAIN	.1	.1	.1	.1	.1	99.9
RMS	.1	.1	7.8	.1	4.4	99.9
VAR	.1	.1	.1	.1	.1	43.4
Finney County, Kansas - 50 meter resolution						
CPU	.1	.1	99.9	.1	99.9	99.9
FCP	.1	.1	9.6	.1	2.7	99.9
FULL	.1	.1	.3	.1	17.3	29.7
TRAIN	.1	.1	7.5	.1	8.7	99.9
RMS	.1	.1	.1	.1	.1	2.3
VAR	.1	.1	.1	.1	.1	44.0
Finney County, Kansas - 60 meter resolution						
CPU	.1	.1	99.9	.1	99.9	99.9
FCP	.1	.1	.1	.1	.1	47.0
FULL	.1	.1	.7	.1	.1	99.9
TRAIN	.1	.1	.7	.1	.2	99.9
RMS	.1	.1	16.9	.1	13.4	47.3
VAR	.1	.1	.1	.1	.1	99.9

Table 2.1-11

EFFECT OF ECHO ON SIX VARIABLES USING SITE AS A BLOCK AND RESOLUTION AS A FIXED FACTOR

(Eight Thematic Mapper Data Sets)

	Cell Width	Cell Homogeneity Threshold	Annexation Threshold	Cell Width X Cell Homogeneity Threshold	Cell Width X Annexation Threshold	Cell Homogeneity Threshold X Annexation Threshold
Degrees of Freedom	2,2	5,5	3,3			
CPU Time	10	1		.1	99	99
Field Center Pixel Performance	25		25	.1	99	99
Full Field Performance	25	1	25	.1	99	99
Training Performance	5	1		.1	99	99
RMS Error		25	10	.1	99	99
Classification Variability	1	1	1	.1	.1	99

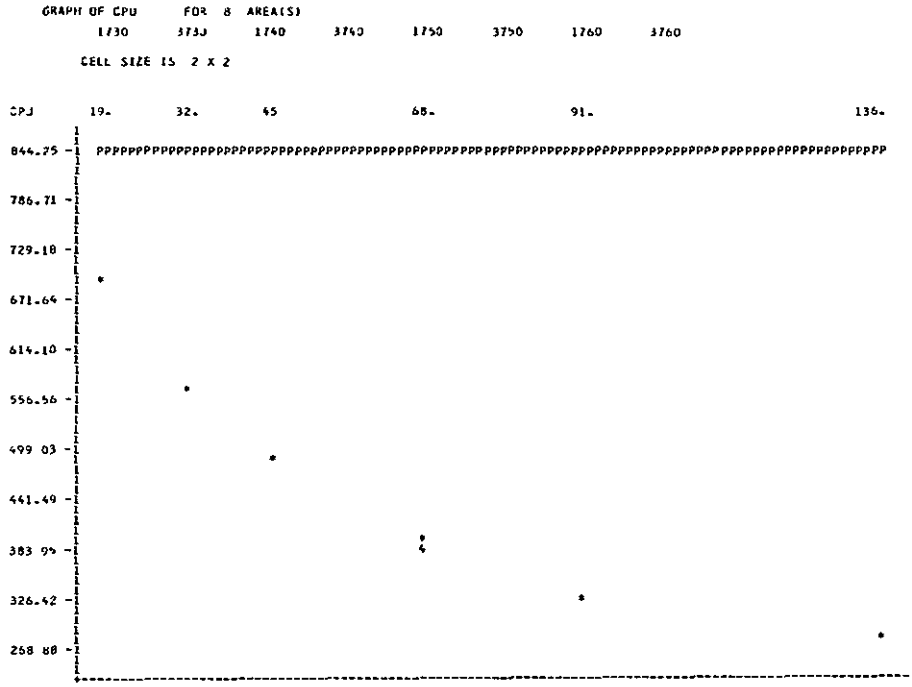

Figure 29
Simulated Thematic Mapper CPU Time

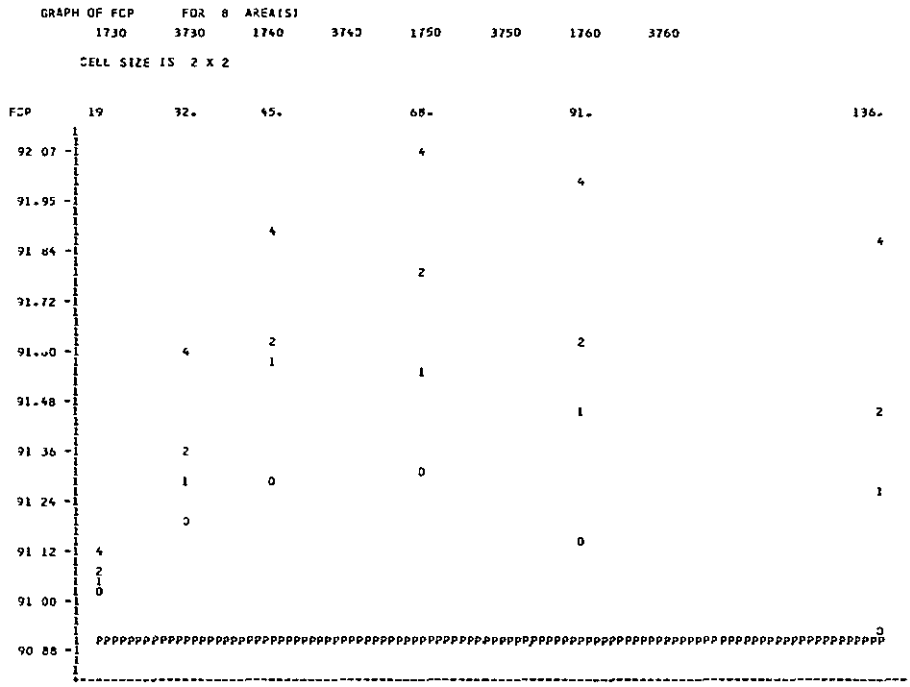

Figure 30
Simulated Thematic Mapper Field Center Pixel Performance

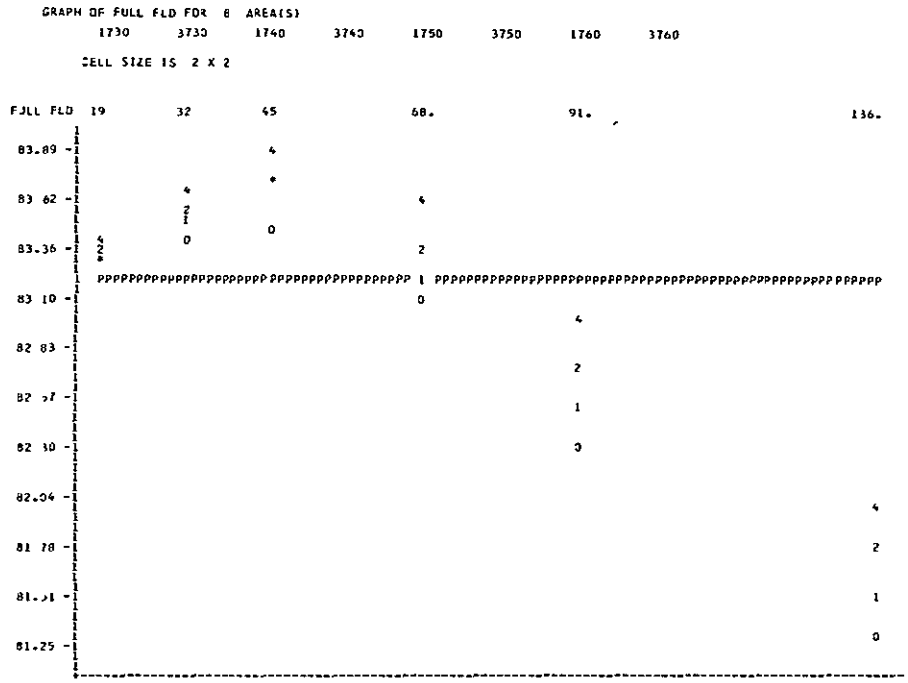

Figure 31
Simulated Thematic Mapper Full Field Performances

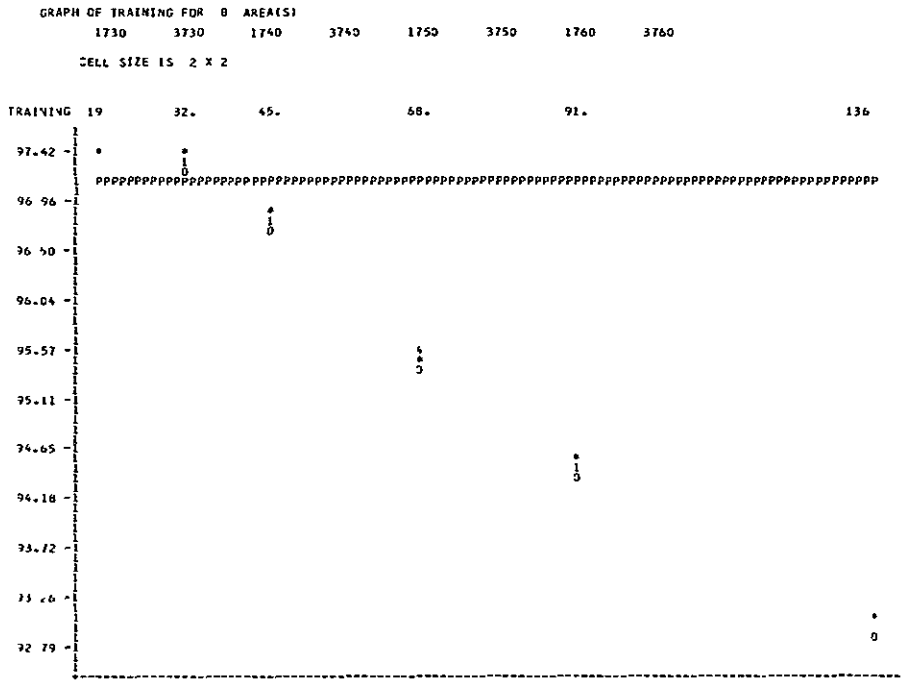

Figure 32
Simulated Thematic Mapper Training Performances

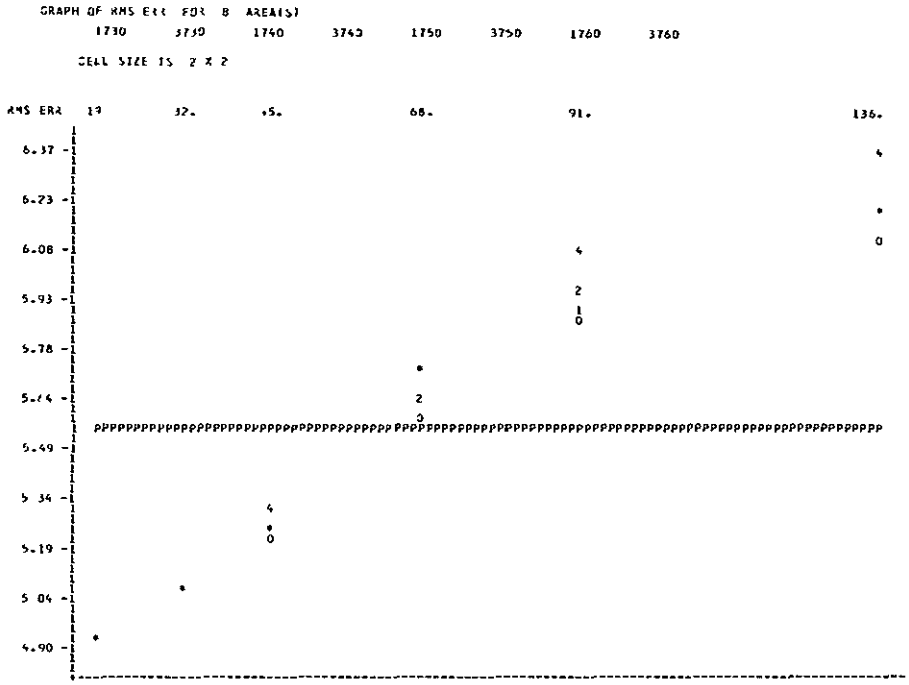

Figure 33
Simulated Thematic Mapper RMS Proportion Errors

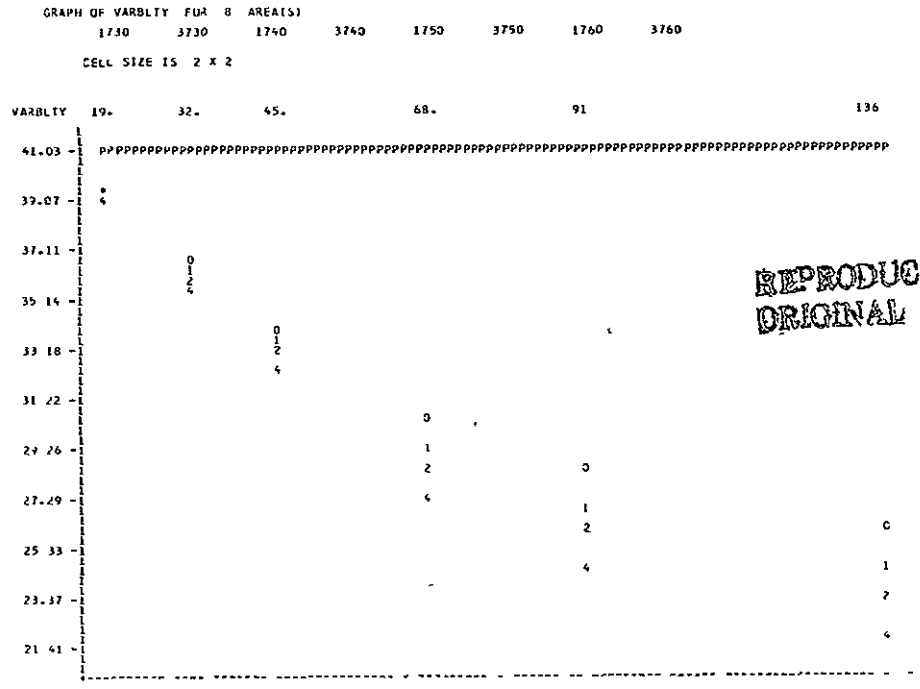

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Figure 34
Simulated Thematic Mapper Classification Variability

The annexation parameter is significant in 63% of the 48 cases involving 6 dependent variables and 2 sites and 4 resolutions of thematic mapper data. It is never significant for CPU time in the individual data sets. When the Thematic Mapper data sets are considered together, the annexation parameter is significant only for variability. As the annexation parameter increases, classification variability decreases.

The interaction of cell width and cell homogeneity is significant for all dependent variables both when the Thematic Mapper data sets are considered together or individually.

The interaction of cell width and annexation is also significant in 63% of the 48 cases in the Thematic Mapper data sets. It is significant only for variability when all the Thematic Mapper data sets are considered together.

The interaction of cell homogeneity and annexation is significant in 8% of the 48 cases of the individual Thematic Mapper data sets and is not significant for any dependent variable when the Thematic Mapper data sets are considered together.

Comparison of the ECHO and the Perpoint Classifier

F-values for the analysis of variance comparing the effects of classification method (ECHO versus perpoint) and resolution size (30, 40, 50 and 60 meters) to the six variables for the optimum parameter setting of the Supervised ECHO classifier for each of the dependent variables is presented in Table 2.1-12.

Table 2.1-12

	Method	Resolution
CPU Time	1204.39*	9.86**
Field Center Pixel Performance	147.63***	1.25
Full Field Performance	74.21***	1.47
Training Field Performance	15.21+	.62
RMS Proportion Error	2.62	.21
Classification Variability	13547.44**	7.23***
Degrees of Freedom	(1,1)	(3,3)

* significant at 1% confidence level

** significant at 5% confidence level

*** significant at a 10% confidence level

\+ significant at a 25% confidence level

Classification variability is reduced as resolution is increased. This result is expected since the field which is 10 pixels wide in the 30 meter data is only 5 pixels wide in the 60 meter data. The CPU time required to perform the classification is increased as the resolution increases.

Results based on classification method are hampered by having only (1,1) degrees of freedom. ECHO requires less CPU time and has less classification variability than the perpoint classifier at a 1% confidence level.

ECHO field center pixel and "full field" performance appear to be superior to the perpoint classifier at a 10% confidence level.

More repetitions are necessary before it can be deomonstrated that ECHO RMS error is significantly less than that of the perpoint classifier for the Thematic Mapper data.

c. Aircraft Results

Tables 2.1-13 and 2.1-14 summarize the analysis of variance results for the effect of the ECHO parameters on the three aircraft data sets taken individually and taken as a block. Figures 35 through 39 present the CPU time, field center pixel performance, "full field" performance, training field performance, and classification variability. RMS values were not calculated because ground truth proportion estimates were not available for all three aircraft sites. The aircraft data sets were sampled only at the 2 by 2 cell size.

As the cell homogeneity parameter increases, field center pixel and training field performance increase (5% confidence levels). As with the LANDSAT and simulated Thematic Mapper data sets, classification variability decreases as annexation and cell selection threshold increase.

The effect of the annexation parameter increases as the cell homogeneity parameter increases for training field performance, classification variability and CPU time.

ECHO - Perpoint Comparison

Though only three aircraft data sets were tested, the Supervised ECHO processor produced results which had significantly less variability than the results produced by the perpoint classifier (5% confidence level). The comparison between the perpoint and the ECHO processor is approaching statistical significance for the other four variables. The following statements can be made for the aircraft data sets at a 15% confidence level.

* ECHO requires less computer time than the perpoint classifier.
* ECHO has higher field center pixel, "full field" and training performances than the perpoint classifier.

For the aircraft data sets, the cell homogeneity value appears to maximize performance for a value in the neighborhood of 70 and an annexation threshold of 4 seems to be optimal.

Table 2.1-13

INDIVIDUAL AIRCRAFT DATA SETS

(Entries are Significance Levels)

Finney County, North Dakota*

	Annexation Threshold	Cell Homogeneity Threshold
CPU Time	.2	.1
Field Center Pixel Performance	.1	.1
Full Field Performance	.1	.1
Training Field Performance	.1	.1
Classification Variability	.1	.1

Williams County, Kansas*

	Annexation Threshold	Cell Homogeneity Threshold
CPU Time	11.2	.1
Field Center Pixel Performance	.2	.1
Full Field Performance	.1	.1
Training Field Performance	.5	.1
Classification Variability	.1	.1

Tippecanoe County, Indiana*

	Annexation Threshold	Cell Homogeneity Threshold
CPU Time	.5	.1
Field Center Pixel Performance	2.4	4.0
Full Field Performance	1.7	21.5
Training Field Performance	.1	.1
Classification Variability	.1	.1

* Degrees of freedom for the Annexation Threshold test are 3,15 and Degrees of freedom for the Cell Homogeneity Threshold are 5,15.

Table 2.1-14

RESULTS FOR ECHO CLASSIFICATIONS OF

AIRCRAFT DATA, USING ALL THREE DATA SETS

	Cell Homogeneity	Annexation Threshold	Interaction
Degrees of Freedom	5,10	3,6	15,30
Field Center Pixel Performance	3.92***	2.516°	1.609°
Full Field Performance	0.92	2.88	1.75***
Training Field Performance	6.84*	4.64***	5.47*
Classification Variability	18.80*	63.33*	21.78*
CPU Time	1.81°	1.78°	3.20*

---

* sig 1%

** sig 5%

*** sig 10%

° sig 25%

← Table entries are F values. Sig. level indicated by symbols.

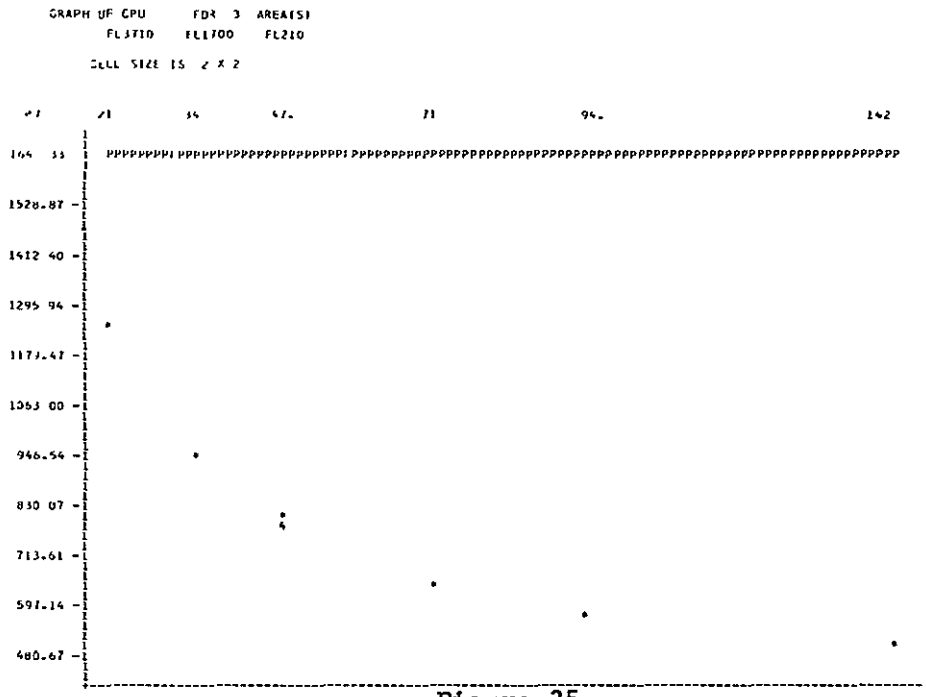

Figure 35
Aircraft CPU time

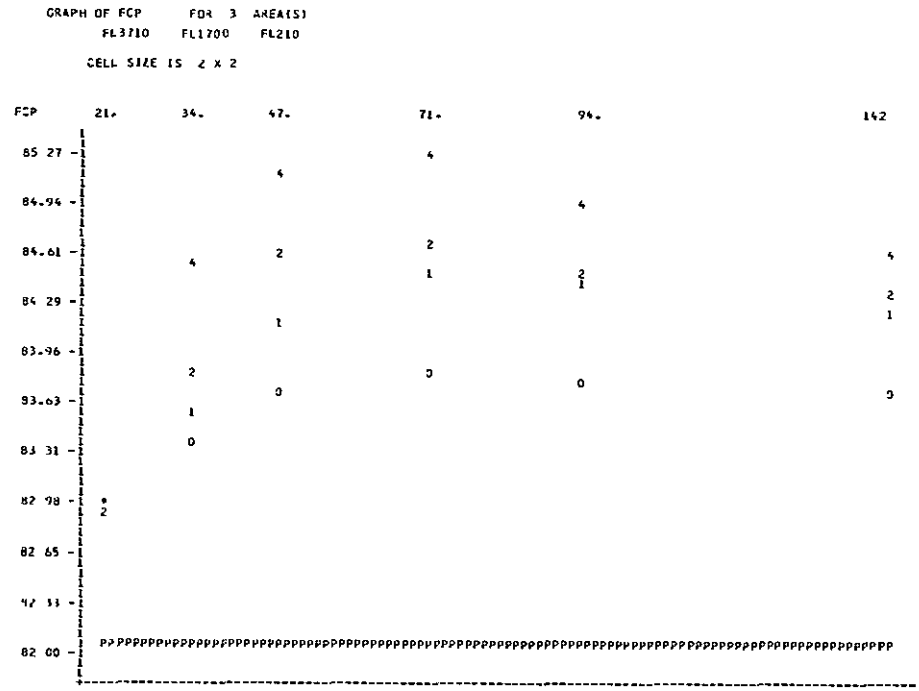

Figure 36
Aircraft Field Center Pixel Performance

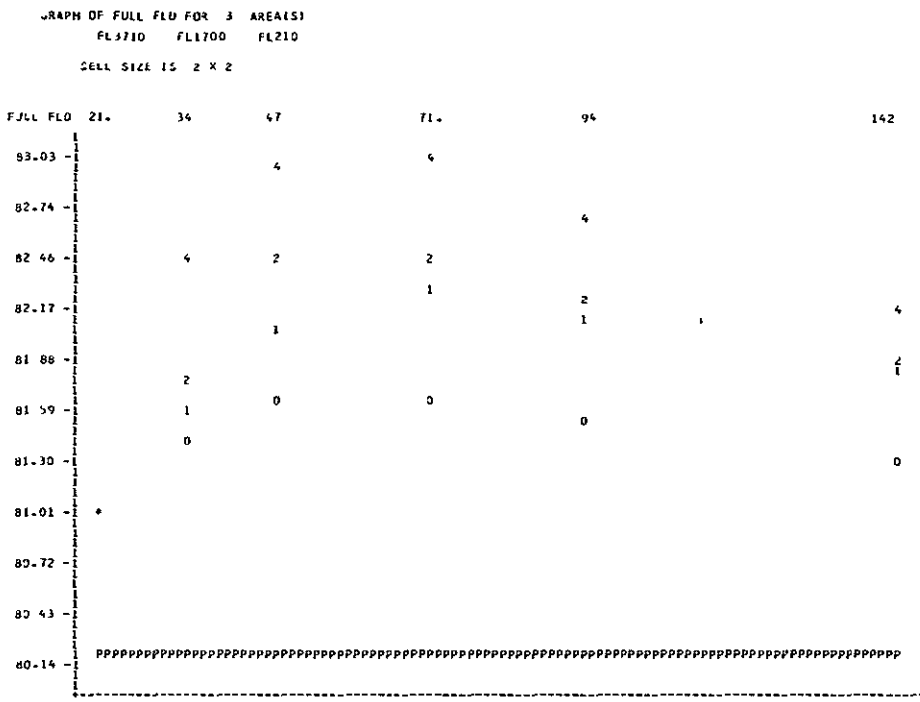

Figure 37
Aircraft Full Field Performance

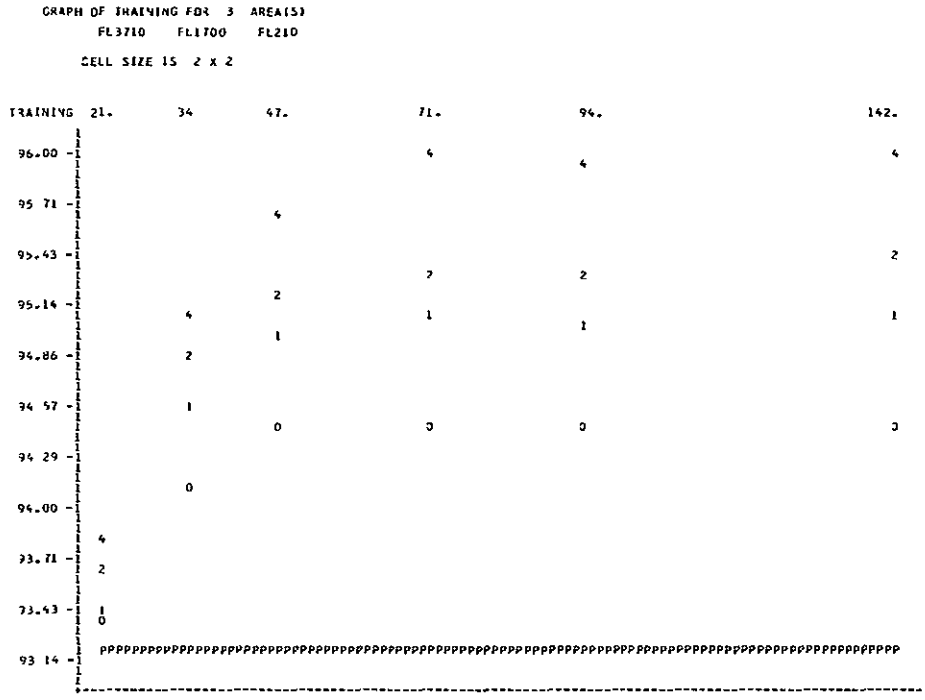

Figure 38
Aircraft Training Field Performance

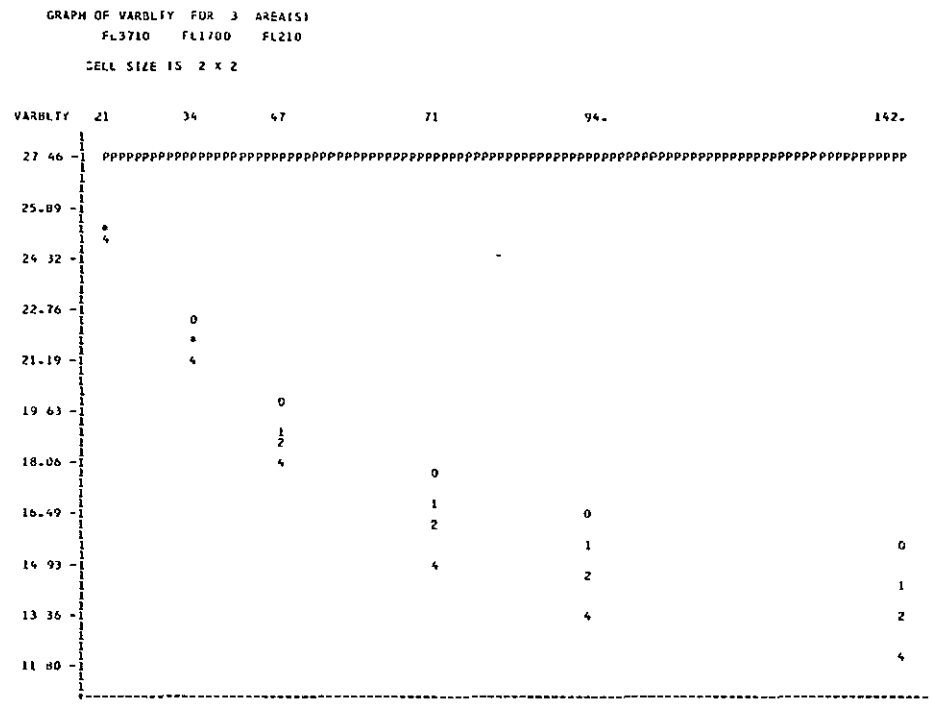

Figure 39
Aircraft Classification Variability

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C. Products for LACIE/AI Evaluation

Magnetic computer tapes containing examples of object maps produced by the Nonsupervised field extraction algorithm are provided in Universal format. Object map tapes are multispectral image storage tapes which have had the data values altered for pixels falling within objects identified by the algorithm. The mean response for the pixels comprising the object replaces the individual response for each constituent pixel of the object.

SUMMARY

The ECHO processor developed at LARS has been implemented in documented FORTRAN programs.

The Supervised ECHO processor has been tested over LANDSAT, simulated Thematic Mapper and aircraft data sets. Evaluations of those tests indicate that:

* ECHO is less expensive than the perpoint classification algorithm (statistically significant for LANDSAT and simulated Thematic Mapper data sets at a 1% confidence level and at a 15% confidence level for the aircraft data sets).
* ECHO provides better field center pixel and "full field" classification performance than the perpoint classifier (5% confidence level on LANDSAT data, 10% confidence level on simulated Thematic Mapper data, 15% confidence level on aircraft data).
* ECHO RMS proportion error is significantly less than that of the perpoint classifier at optimal parameter settings for the LANDSAT data. Proportion estimation for the Thematic Mapper data set was not significantly different for the two classification methods.

* ECHO classification results are less variable than the classification results of the perpoint classifier. This result is statistically significant at a 5% confidence level for all data sets.

The effects of the three ECHO parameters on six variables were monitored. In general, cell homogeneity had the strongest effect on the six variables. Cell width had a strong effect on the variables when the data sets were considered individually. However, when the data sets were considered together, the effect of cell width was not significant for RMS error and was less significant than the cell homogeneity parameter for field center pixel and "full field" performances, indicating the effects of cell width are sometimes opposite in direction for differing data sets. The annexation threshold had a significant effect on classification variability and CPU time but a weak effect on the other variables.

CONCLUSIONS

ECHO successfully exploits the redundancy of states characteristics of sampled imagery of ground scenes to achieve better classification accuracy, reduce the number of classifications required, and reduce the variability of the classification results. The information required to produce ECHO classifications are cell size, cell homogeneity, and cell-to-field annexation parameters, input data, and a class-conditional marginal density statistics deck.

Future research should be directed towards developing methods for utilizing the information produced by the ECHO processors to aid in the training process. For example, the singular cell map produced by the Supervised ECHO processor (see Figure 40) provides information on training adequacy. Singular cells are represented on this map by 0's. For the Supervised processor, cells are identified as being singular when the likelihood of the cell belonging to the most likely of the available classes falls below a threshold. Therefore, when a cell is categorized as "singular", it is either because it contains pixels from more than one class, or because the spectral class of the field is not represented in the available class statistics. Large groups of contiguous singular cells will occur when one or more spectral classes have been omitted. The singular cell map may indicate where additional training statistics should be collected.

The intermediate tape produced by the Nonsupervised ECHO processor contains the statistics for each homogeneous object identified by the field extraction routine. It is possible that this spectral-spatial cluster will contain all the information an analyst will need to produce a class statistics deck superior to what would be produced by traditional training procedures for a smaller investment of analyst time than is now required.

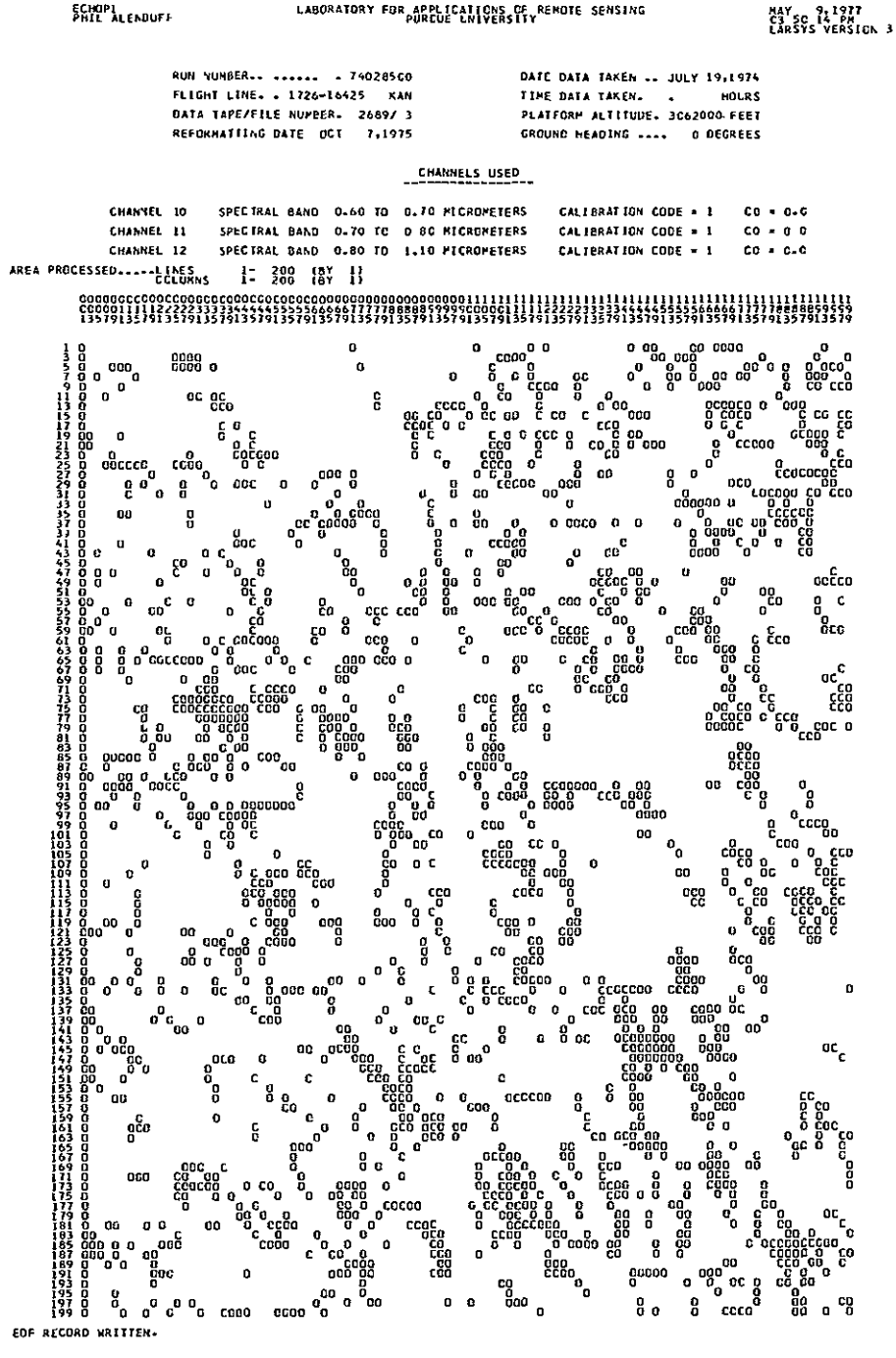

Figure 40
Example of the Supervised ECHO Singular Cell Map

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Lastly, background research should be performed to determine what training techniques are optimal for a field classifier. ECHO performance may be enhanced by utilizing training techniques developed specifically for it, rather than techniques which are optimal for the perpoint classifier.

References

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APPENDIX A

TASK 2.1

PROGRAM ABSTRACTS AND LISTINGS FOR THE SUPERVISED ECHO PROCESSOR

LARS Program Abstract _____

MODULE IDENTIFICATION

Module Name: SECSUP **Function Name:** SECSUP

Purpose: Supervised ECHO supervisor routine.

System/Language: CMS/FORTRAN

Author: P. D. Alenduff **Date:** 03/30/77

Latest Revisor: _____ **Date:** _____

MODULE ABSTRACT

SECSUP is the supervisor routine for the supervised ECHO classifier.

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1. Module Usage

SECSUP

Calling sequence:

CALL SECSUP

SECSUP is the supervisor routine for the supervised ECHO classifier. It is called with no arguments.

2. Internal Description

The program SECSUP basically controls the program sequencing for the many subprograms involved in the supervised ECHO classifier. Two subroutines are called by SECSUP: SECRDR and SECINT.

SECRDR is the control card reader for reading the user input data cards and is called first. SECINT is the initialization routine for the SECHO function and is called to handle utilization of all input/output operations as well as classification processing. For more detailed descriptions of these modules, see their program abstracts.

Two common blocks are used in SECSUP. GLOCOM, the main LARSYS common block and SECCOM, the common block for the supervised ECHO function are included.

3. Input Description

Not applicable

4. Output Description

Two messages are produced and written to unit TYPEWR, the console.

SUPERVISED ECHO FUNCTION REQUESTED

Signifies beginning of the function.

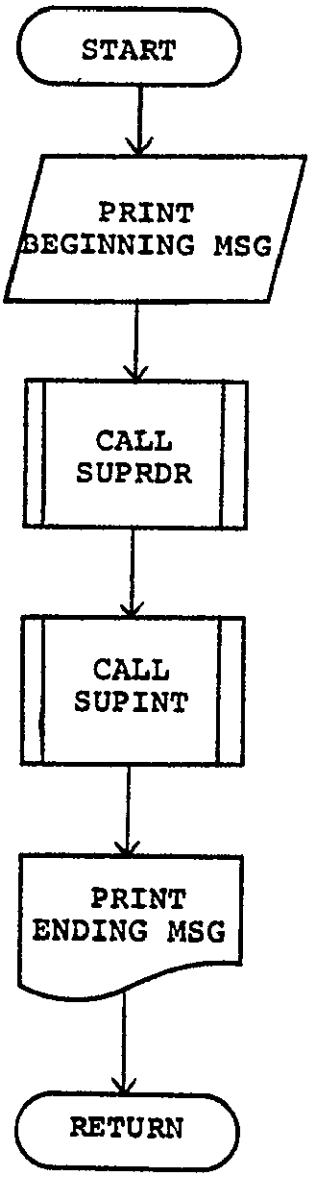
SUPERVISED ECHO FUNCTION COMPLETED

Signifies end of the function.

5. Supplemental Information

Two COMMON blocks are included in SECSUP: GLOCOM
SECCOM

6. Flowchart


START
PRINT BEGINNING MSG
CALL SUPRDR
CALL SUPINT
PRINT ENDING MSG
RETURN

FILE SECSUP

```
C      SECSUP  LARS    XXXX                                                    SEC00010
C                                                                              SEC00020
C*************************************************************************** SEC00030
C                                                                              SEC00040
C  SECSUP - SUPERVISOR ROUTINE FOR SUPERVISED ECHO FUNCTION                    SEC00050
C           WRITTEN 01/20/77 BY P.D. ALENDUFF                                  SEC00060
C                                                                              SEC00070
C*************************************************************************** SEC00080
C                                                                              SEC00090
0001        SUBROUTINE SECSUP                                                  SEC00100
C                                                                              SEC00110
0002        IMPLICIT INTEGER * 4 (A-Z)                                         SEC00120
C                                                                              SEC00130
0003        COMMON /GLOCOM/ BLANK, CARD(20), CHKOUT, COPFIL, CLASSR, CLASSX,   SEC00140
           1    CLUSTX, CONPUT, CPYOUT, CRDRDR, CRDSEQ, DATAPE,                SEC00150
           2    DUPLTP, DUPRUN, ERRMSG, FBPNT,                                 SEC00160
           3    FILESV, FLDBND, HDATA, HEAD(88), ID(200), IMAGEX,              SEC00170
           4    IMARK, KEYBD, MAPTAP, MAXCHA, MAXCLS,                          SEC00180
           5    PAGSIZ, PNCH, POINT, PRESUX, PRNTR, READIN,                    SEC00190
           6    RESTRT, RUNFIL, RUNTAB(10,3),                                  SEC00200
           7    SDATA, SEPARX, SEPTPX, SPARE(10), TEMPAS(30),                  SEC00210
           8    TPSTAT(6), TTFLDX ,TYPEWR,                                     SEC00220
           9    TOP, ARRAY(12500)                                              SEC00230
C                                                                              SEC00240
0004        REAL * 8 ARRAY                                                     SEC00250
0005        REAL * 4 FRQCAL(5,30)                                              SEC00260
0006        INTEGER * 4 COMENT(16), DATE(5), HED1(16), HED2(16), TIME(5)       SEC00270
0007        INTEGER * 2 BLANK2                                                 SEC00280
0008        LOGICAL * 4 CHKOUT                                                 SEC00290
0009        LOGICAL * 1 BLANK1                                                 SEC00300
0010        EQUIVALENCE (DATSAV,ID(1)), (CURRUN,ID(3)), (FRQCAL(1),ID(51)),    SEC00310
           1        (HED1(1),HEAD(8)), (DATE(1),HEAD(26)), (HED2(1),HEAD(39)), SEC00320
           2        (TIME(1),HEAD(58)), (COMENT(1),HEAD(72)),                  SEC00330
           3        (MAPSAV,TPSTAT(1)),                                        SEC00340
           4        (SEPSCR,TPSTAT(2)), (DUPIN,TPSTAT(3)), (DASTAT,TPSTAT(4)), SEC00350
           5        (COPSER,TPSTAT(5)), (TRAOUT,TPSTAT(6)),                    SEC00360
           6        (BLANK,BLANK2,BLANK1)                                      SEC00370
C                                                                              SEC00380
C                                                                              SEC00390
0011        COMMON /SECCOM/ BUFROZ,CSELEC,CSET(3,30),CSET3(3,30),THRES,CELSIZ, SEC00400
           1 CELWTH,INFO(17),INPUT, INTTAP, INTFIL, JPTS, LINES, NOCLS, NOFET, SEC00410
           2 NOFET3,NOPOOL,NWORD,NWORD2, NVR, OUTPUT, POLNAM(2,60), PREFIX(2),  SEC00420
           3 PTS, RQTAPE, RQFILE, SYMCNT, VARSZ3, CSEL(30), CSEL3(30),         SEC00430
           3 FETVEC(30), FETVC3(30), POLPTR(2,60), POLSTK(60),                 SEC00440
           4 CDFLAG, CLSMAP, CSET1(3,30), OBJMAP, PHASE1, PHASE2, POLNM1(60),  SEC00450
           5 PRSTAT, SYM(60), SYMMTX(60)                                       SEC00460
C                                                                              SEC00470
0012        REAL * 4 CSELEC, CSET, CSET3, THRES                                SEC00480
C                                                                              SEC00490
0013        INTEGER * 2 CSEL, CSEL3, FETVEC, FETVC3, POLPTR, POLSTK            SEC00500
C                                                                              SEC00510
0014        LOGICAL * 1 CDFLAG, CLSMAP, CSET1, OBJMAP, PHASE1, PHASE2, POLNM1, SEC00520
           1 PRSTAT                                                            SEC00530
C                                                                              SEC00540
C                                                                              SEC00550
C      CALL READER AFTER INITIAL MESSAGE PRODUCED                              SEC00560
C                                                                              SEC00570
0015        WRITE (TYPEWR,100)                                                 SEC00580
0016      100 FORMAT(' I0000  SUPERVISED ECHO FUNCTION REQUESTED    (SECSUP)') SEC00590
0017        CALL SECRDR                                                        SEC00600
C                                                                              SEC00610
C CALL PROCESSING ROUTINE THEN PRINT TERMINATION MSG                           SEC00620
C                                                                              SEC00630
0018        CALL SECINT                                                        SEC00640
C                                                                              SEC00650
0019        WRITE(TYPEWR,9000)                                                 SEC00660
0020     9000 FORMAT(' I0000  SUPERVISED ECHO FUNCTION COMPLETED   (SECSUP)!') SEC00670
0021        RETURN                                                             SEC00680
0022        END                                                                SEC00690
```

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LARS Program Abstract _____

MODULE IDENTIFICATION

Module Name: SECCOM **Function Name:** SECSUP

Purpose: Common block for supervised ECHO function

System/Language: CMS/FORTRAN

Author: P. D. Alenduff **Date:** 03/30/77

Latest Revisor: _____ **Date:** _____

MODULE ABSTRACT

SECCOM is the common block for the supervised ECHO classifier.

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SECCOM

Variable Description

BUFROZ	INTEGER*4 Number of rows of cells in buffer.
CSELEC	REAL*4 Cell selection parameter.
CSET (3,30)	REAL*4 Channel calibration code vector from statistics.
CSET3 (3,30)	REAL*4 Channel calibration code vector from channels card.
THRES	REAL*4 Annexation threshold.
CELSIZ	INTEGER*4 Number of data points in a cell.
CELWTH	INTEGER*4 Number of rows in cell.
INFO (16)	INTEGER*4 Array for storing field description information and areas to be classified.
INPUT	INTEGER*4 Unit number for input tape.
INTTAP	INTEGER*4 Tape number of intermediate tape.
INTFIL	INTEGER*4 File number of intermediate tape.
JPTS	INTEGER*4 Number of cells horizontally in data area.
LINES	INTEGER*4 Number of rows of cells in area to be processed.
NOCLS	INTEGER*4 Number of classes in statistics deck.

NOFET	INTEGER*4 Number of channels in statistics deck.
NOFET3	INTEGER*4 Number of channels to be used in classification.
NOPOOL	INTEGER*4 Number of pools to be used in classification.
NWORD	INTEGER*4 Integer array word counter.
NWORD2	INTEGER*4 Integer word counter.
NVR	INTEGER*4 Number of channels on data tape.
OUTPUT	INTEGER*4 Unit number of output file.
POLNAM (2,60)	INTEGER*4 Names of statistics classes.
PREFIX(2)	INTEGER*4 Prefix information used in writing results.
RQTAPE	INTEGER*4 Tape number of the results tape.
RQFILE	INTEGER*4 File number of the results file.
SYMCNT	INTEGER*4 Number of user supplied symbols.
VARSZ3	INTEGER*4 Number of words to store half of a triangular covariance matrix for classes (channels * (channels + 1))/2.
CSEL(30)	INTEGER*2 Channel select vector from statistics.

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CSEL3(30)	INTEGER*2 Channel select vector from channels card.
FETVEC(30)	INTEGER*2 Array of channel numbers from statistics deck.
FETVC3(30)	INTEGER*2 Array of channel numbers from channels card.
POLPTR(2,60)	INTEGER*2 Array of classification pools and pooling information.
POLSTK(60)	INTEGER*2 Array of stacked class numbers organized by pool request.
CDFLAG	LOGICAL*1 Logical variable signalling input of statistics on cards in control card deck.
CLSMAP	LOGICAL*1 Logical variable requesting production of classification map.
CSET1(3,30)	LOGICAL*1 Logical array indicating storage of calibration values by user.
OBJMAP	LOGICAL*1 Logical variable requesting production of singular cell map in phase 2 (annexation).
PHASE1	LOGICAL*1 Logical variable requesting initial cell processing is to be carried out.
PHASE2	LOGICAL*1 Logical variable indicating annexation of cells is to be carried out.
POLNM1(60)	LOGICAL*1 Logical array signalling that the name for POOL (I) has been stored.

PRSTAT	LOGICAL*1 Logical variable indicating request to print statistics information.
SYM(60)	LOGICAL*1 Array of user supplied symbols.
SYMMTX(60)	LOGICAL*1 Array of default symbols.

FILE SECCOM

```
      C     SECCOM   LARS  XXXX                                                    SUP00010
      C                                                                            SUP00020
      C*************************************************************************SUP00030
      C                                                                            SUP00040
      C SECCOM - COMMON BLOCK FOR SUPERVISED ECHO                                  SUP00050
      C          WRITTEN 11/22/76 BY P.D. ALENDUFF                                 SUP00060
      C                                                                            SUP00070
      C*************************************************************************SUP00080
      C                                                                            SUP00090
      C VARIABLES USED IN SECCOM - COMMON BLOCK FOR SUPERVISED ECHO                SUP00100
      C                                                                            SUP00110
0001        BLOCK DATA                                                           SUP00120
      C                                                                          SUP00130
0002        IMPLICIT INTEGER * 4 (A-Z)                                           SUP00140
      C                                                                          SUP00150
0003        COMMON /SECCOM/ BUFROZ,CSELEC,CSET(3,30),CSET3(3,30),THRES,CELSIZ,   SUP00160
           1 CELWTH,INFO(17),INPUT, INTTAP, INTFIL, JPTS, LINES, NOCLS, NOFET,   SUP00170
           2 NOFET3,NOPOOL,NWORD,NWORD2, NVR, OUTPUT, POLNAM(2,60), PREFIX(2),   SUP00180
           3 PTS, RQTAPE, RQFILE, SYMCNT, VARSZ3, CSEL(30), CSEL3(30),           SUP00190
           3 FETVEC(30), FETVC3(30), POLPTR(2,60), POLSTK(60),                   SUP00200
           4 CDFLAG, CLSMAP, CSET1(3,30), OBJMAP, PHASE1, PHASE2, POLNM1(60),    SUP00210
           5 PRSTAT, SYM(60), SYMMTX(60)                                         SUP00220
      C                                                                          SUP00230
0004        REAL * 4 CSELEC, CSET, CSET3, THRES                                  SUP00240
      C                                                                          SUP00250
0005        INTEGER * 2 CSEL, CSEL3, FETVEC, FETVC3, POLPTR, POLSTK              SUP00260
      C                                                                          SUP00270
0006        LOGICAL * 1 CDFLAG, CLSMAP, CSET1, OBJMAP, PHASE1, PHASE2, POLNM1,   SUP00280
           1 PRSTAT                                                              SUP00290
      C                                                                          SUP00300
      C                                                                          SUP00310
0007        DATA SYMMTX/'1','2','3','4','5','6','7','8','9','A','B',            SUP00320
           1'C','D','E','F','G','H','I','J','K','L','M','N',                     SUP00330
           2'O','P','Q','R','S','T','U','V','W','X','Y','Z',                     SUP00340
           3'0','+','=','*','$','/','(',')',                                     SUP00350
           4'1','2','3','4','5','6','7','8','9','A','B','C',                    SUP00360
           5'D','E','F','G'/                                                     SUP00370
      C                                                                          SUP00380
0008        END                                                                  SUP00390
```

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LARS Program Abstract _____

MODULE IDENTIFICATION

Module Name: SECRDR Function Name: SECSUP

Purpose: Control card reader for Supervised ECHO Function

System/Language: CMS/FORTRAN

Author: P. D. Alenduff Date: 3/30/77

Latest Revisor: _____ Date: _____

MODULE ABSTRACT

SECRDR is the control card reader for the Supervised ECHO function. After user requests are read, many different checks are made to detect any control card errors. The input or output classification or intermediate tapes are then mounted on the appropriate devices, and an options list is printed to document user selections.

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1. Module Usage

SECRDR

Calling sequence:

CALL SECRDR

SECRDR is called without parameters to read user option selections and detect any errors on specified combinations of options. Upon error detection, either corrected data is requested or the function is terminated following an information message detailing the error. Output and/or intermediate tapes and the multispectral image storage tape are mounted and a list of selected options is produced.

2. Internal Description

SECRDR first performs initialization on all variables stored in SECCOM common block to set up any default options and clear any previously selected options. Control card decoding is heavily dependent upon LARSYS control card processing routines CTLWRD and BCDVAL. CTLWRD is called with a list of acceptable keywords to read input control cards. The number of the matching keyword is returned to SECRDR and a branch is made to the code that will appropriately decode the remainder of the control card. Other special purpose LARSYS routines used for control card decoding include CHANEL for decoding the CHANNELS card, and POLSCN for decoding the CLASSES card.

After encountering a DATA or END card, a check is made for a request of at least one channel on the CHANNELS card. The cell width parameter is then checked to be greater than or equal to 2. The cell selection option must also be non-negative, and annexation threshold THRES must be zero or positive. If both

an object map and classification map are requested, only an object map is produced. At this point, tape and disk parameters are checked. If OPTIONS INTERMEDIATE (start processing with the intermediate tape) is selected, a tape number must be supplied. If an intermediate tape number is supplied, a file number must also be specified.

Upon specification of OPTIONS INTERMEDIATE, processing begins with the intermediate tape and a results file is produced. If, however, no OPTIONS INTERMEDIATE request is made and both an intermediate tape number and a results location is specified, a conflict is recognized and EXECUTION is terminated. If a results location is needed and none is specified, more data is requested. A file number must be specified when a tape location is selected. Specifications of both tape and disk options for classification results information causes termination.

After the error checking sequence is finished, tapes are mounted on the appropriate devices by calls to MTAPE. Initialization, if requested, is performed on the results or intermediate tape. A list of the selected options is then produced. Both GLOCOM and SECCOM common blocks are used by SECRDR.

3. Input Description

Input data is read from unit READIN in GLOCOM which is either CRDRDR, the card reader, or KEYBD, the console keyboard, when cards are typed in by the user. This selection is accomplished by the LARSYS system.

4. Output Description

Output is written to both PRNTR, the printer, and TYPEWR,

an object map and classification map are requested, only an object map is produced. At this point, tape and disk parameters are checked. If OPTIONS INTERMEDIATE (start processing with the intermediate tape) is selected, a tape number must be supplied. If an intermediate tape number is supplied, a file number must also be specified.

Upon specification of OPTIONS INTERMEDIATE, processing begins with the intermediate tape and a results file is produced. If, however, no OPTIONS INTERMEDIATE request is made and both an intermediate tape number and a results location is specified, a conflict is recognized and EXECUTION is terminated. If a results location is needed and none is specified, more data is requested. A file number must be specified when a tape location is selected. Specifications of both tape and disk options for classification results information causes termination.

After the error checking sequence is finished, tapes are mounted on the appropriate devices by calls to MTAPE. Initialization, if requested, is performed on the results or intermediate tape. A list of the selected options is then produced. Both GLOCOM and SECCOM common blocks are used by SECRDR.

3. Input Description

Input data is read from unit READIN in GLOCOM which is either CRDRDR, the card reader, or KEYBD, the console keyboard, when cards are typed in by the user. This selection is accomplished by the LARSYS system.

4. Output Description

Output is written to both PRNTR, the printer, and TYPEWR,

the console device. A variety of error messages is produced by SECRDR, and brief list follows:

ERROR IN TAPE OR FILE SPECIFICATION-TYPE CORRECT CARD

A non-numeric character was entered as either a tape or file number.

ERROR IN PARAMETER VALUE SPECIFICATION-TYPE CORRECT CARD

A non-numeric character was specified as the cell size, cell selection, or annexation value.

YOU HAVE ENTERED X SYMBOLS. THE MAXIMUM ALLOWED IS 60. EXCESS SYMBOLS WILL NOT BE USED.

The maximum number of symbols that can be stored is 60. Only the first 60 can be used.

CELL SIZE MUST BE GREATER THAN OR EQUAL TO TWO-DEFAULT OF 2 ASSUMED-TYPE CORRECT CARD

The CELL SIZE (X) parameter cannot be less than 2. A corrected card must be supplied.

CELL SELECTION PARAMETER MUST BE GREATER THAN OR EQUAL TO ZERO-TYPE CORRECT CARD

The CELL SELECT (X) entry cannot be negative, a new card is requested.

ANNEXATION THRESHOLD MUST BE NON-NEGATIVE. TYPE A CORRECTED ANNEXATION THRESHOLD CARD.

The THRES specified is negative. The user is requested to correct the error.

BOTH SINGULAR CELL AND CLASSIFICATION MAPS REQUESTED. ONLY OBJECT MAP WILL BE PRODUCED

Only one map can be produced during annexation. If both are requested, only the singular cell map will be printed.

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NO INTERMEDIATE TAPE SUPPLIED FOR OPTIONS INTERMEDIATE. TYPE IN INTERMEDIATE CARD

When requesting that processing start from an intermediate tape, an intermediate tape number must be specified.

INTERMEDIATE FILE OR INITIALIZE MUST BE SPECIFIED. TYPE ADDITIONAL INTERMEDIATE CARD

When producing an intermediate tape, some indication of file number must be given.

BOTH INTERMEDIATE TAPE AND RESULTS LOCATION SPECIFIED WITHOUT OPTIONS INTERMEDIATE-JOB TERMINATED

It is impossible to determine which part of the classification should be performed when this set of options is supplied. Execution is terminated.

EITHER INTERMEDIATE TAPE OR RESULTS LOCATION MUST BE SPECIFIED WITHOUT OPTIONS INTERMEDIATE. TYPE IN ADDITIONAL CARD

Some output file is needed for processing. Additional information is requested.

EITHER RESULTS FILE OR INITIALIZE MUST BE REQUESTED. TYPE IN ADDITIONAL RESULTS CARD

When producing a results tape, some indication of file number must be given.

NO RESULTS DESTINATION SPECIFIED-TYPE IN RESULTS CARD

Either tape and file or disk must be specified when results will be produced. Additional information is requested.

BOTH RESULTS TAPE PARAMETERS AND DISK SPECIFIED-FUNCTION TERMINATED

Either tape or disk can be selected for results but not both.

BOTH FILE AND INITIALIZE REQUESTED FOR INTERMEDIATE TAPE-FILE REQUEST IGNORED

The intermediate output tape is initialized. Only file 1 can be initialized.

BOTH FILE AND INITIALIZE REQUESTED FOR RESULTS TAPE-FILE REQUEST IGNORED

The results tape is initialized. Only file 1 can be initialized.

In addition to these messages, the list of options selected is printed on the unit PRNTR.

5. Supplemental Information

Common blocks GLOCOM and SECCOM are used by SECRDR.

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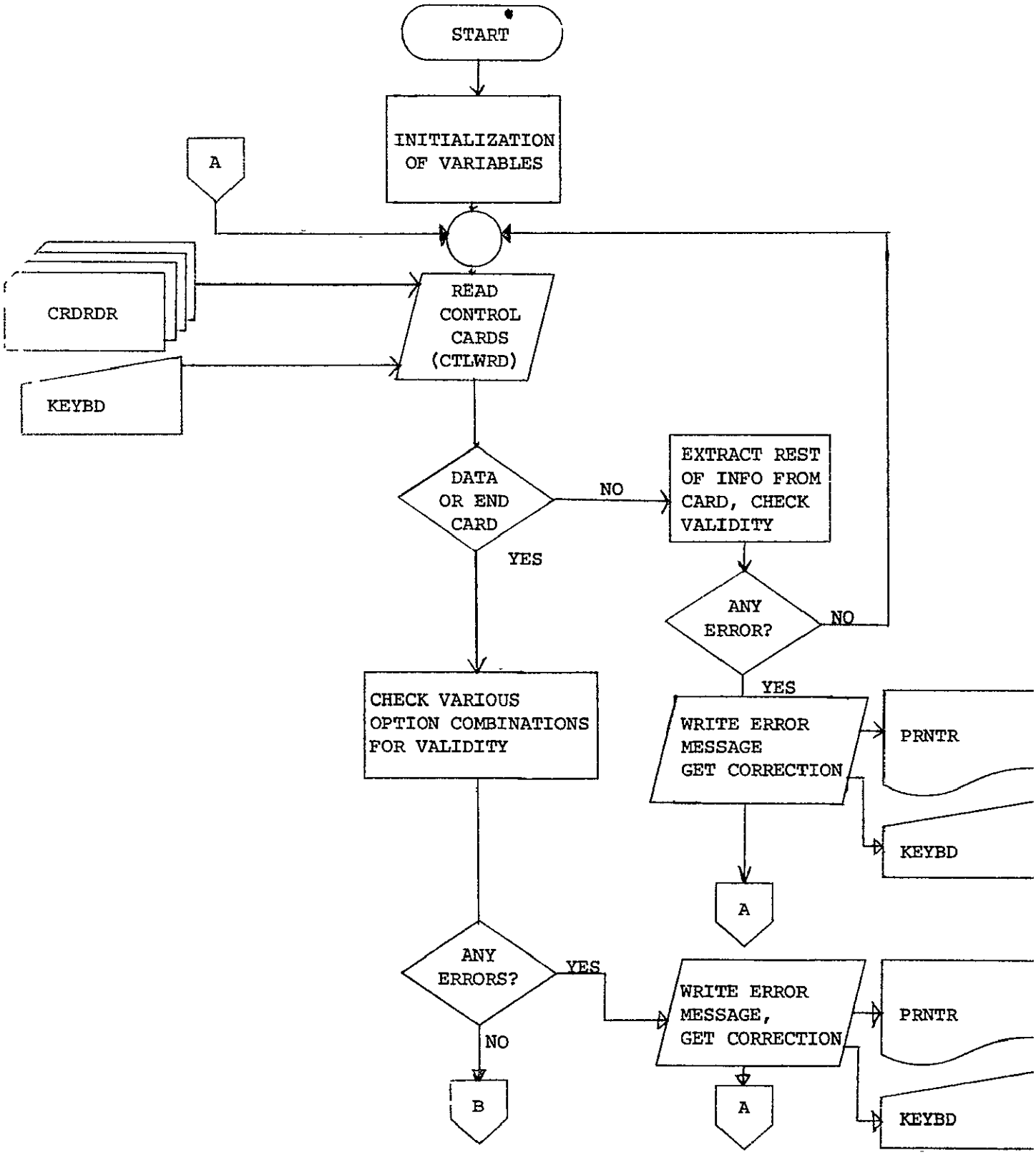

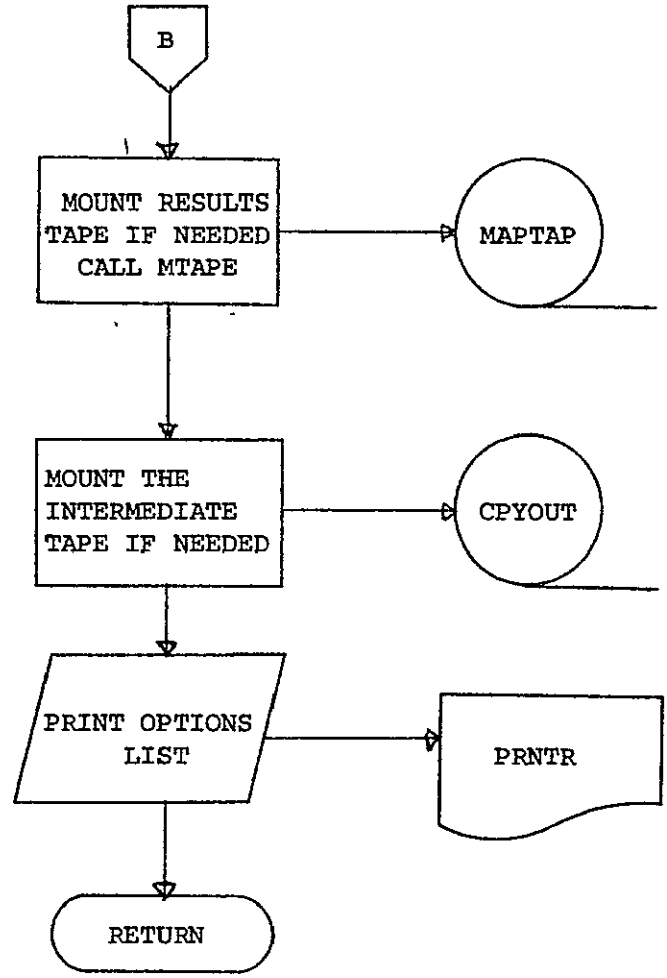
B
MOUNT RESULTS TAPE IF NEEDED CALL MTAPE
MAPTAP
MOUNT THE INTERMEDIATE TAPE IF NEEDED
CPYOUT
PRINT OPTIONS LIST
PRNTR
RETURN

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```
 FORTRAN IV G LEVEL  20.7              SECRDR          DATE = 77129        15018006              PAGE 0001
FILE SECRDR

                C    SECRDR     LARS    XXXX                                                          SUP00010
                C                                                                                     SUP00020
                C*****************************************************************                  SUP00030
                C                                                                                     SUP00040
                C   SECRDR - CONTROL CARD READER FOR SUPERVISED ECHO                                  SUP00050
                C                                                                                     SUP00060
                C*****************************************************************                  SUP00070
                C                                                                                     SUP00080
   0001                 SUBROUTINE SECRDR                                                             SUP00090
                C                                                                                     SUP00100
   0002                 IMPLICIT INTEGER * 4 (A-Z)                                                    SUP00110
                C                                                                                     SUP00120
   0003                 COMMON /GLCCOM/ BLANK, CARD(20), CHKOUT, COPFIL, CLASSR, CLASSX,              SUP00130
                     1    CLUSTX, CONPUT, CPYCOT, CRDADR, CRDSEQ, DATAPE,                           SUP00140
                     2    DUPLTP, DUPRUN, ERRMSG, FAPNT,                                            SUP00150
                     3    FILESY, FLDBND, HDATA, HEAD(88), ID(2000), IMAGEX,                        SUP00160
                     4    IMARK, KEYBD, MAPTAP, MAXCHA, MAXCLS,                                     SUP00170
                     5    PAGSIZ, PNCH, PDINT, PRESUX, PRNTR, READIN,                               SUP00180
                     6    RESTRT, RUNFIL, RUNTAB(10,3),                                             SUP00190
                     7    SDATA, SEPARX, SEPTPS, SPARE(10), TEMPAS(30),                             SUP00200
                     8    TPSTAT(6), TTFLDX ,TYPEWR,                                                SUP00210
                     9    TOP( ARRAY(12500)                                                         SUP00220
                C                                                                                     SUP00230
   0004                 REAL * 8 ARRAY                                                                SUP00240
   0005                 REAL * 4 FROCAL(5,30)                                                         SUP00250
   0006                 INTEGER * 4 COMENT(16), DATE(5), HED1(16), HED2(16), TIME(5)                  SUP00260
   0007                 INTEGER * 2 BLANK2                                                            SUP00270
   0008                 LOGICAL * 4 CHKOUT                                                            SUP00280
   0009                 LOGICAL * 1 BLANK1                                                            SUP00290
   0010                 EQUIVALENCE (DATSAV,ID(1)), (CURRUN,ID(3)), (FROCAL(1),ID(5)),               SUP00300
                     1    (HED1(1),HEAD(8)), (DATE(1),HEAD(26)), (HED2(1),HEAD(39)),               SUP00310C
                     2    (TIME(1),HEAD(58)), (COMENT(1),HEAD(72)),                                 SUP00320
                     3    (MAPSAV,TPSTAT(1)),                                                       SUP00330
                     4    (SEPSCR,TPSTAT(2)), (DUPIN,TPSTAT(3)), (DASTAT,TPSTAT(4)),               SUP00340
                     5    (COPSER,TPSTAT(5)), (TRAOUT,TPSTAT(6)),                                   SUP00350
                     6    (BLANK,BLANK2,BLANK1)                                                     SUP00360
                C                                                                                     SUP00370
                CC                                                                                    SUP00380
   0011                 COMMON /SECCOM/ BUFROZ,CSELEC,CSET(3,30),CSET3(3,30),THRES,CELSIZ,           SUP00390
                     1 CELWTH,INFO(17),INPUT, INTTAP, INTFIL, JPTS, LINES, NDCLS, NDFET,           SUP00400
                     2 NOFET3,NOPOOL,NWORD,NWORD2, NVR, OUTPUT, POLNAM(2,60), PREFIX(2),           SUP00410
                     3 PTS, ROTAPE, ROFILE, SYMCNT, VARSZ3, CSEL(30), CSEL3(30),                   SUP00420
                     3 FETVEC(30), FETVC3(30), POLPTR(2,60), POLSTK(60),                           SUP00430
                     4 CDFLAG, CLSMAP, CSET1(3,30), OBJMAP, PHASE1, PHASE2, POLNM1(60),            SUP00440
                     5 PRSTAT, SYM(60), SYMTX(60)                                                  SUP00450
                C                                                                                     SUP00460
   0012                 REAL * 4 CSELEC, CSET, CSET3, THRES                                           SUP00470
                C                                                                                     SUP00480
   0013                 INTEGER * 2 CSEL, CSEL3, FETVEC, FETVC3, POLPTR, POLSTK                       SUP00490
                C                                                                                     SUP00500
   0014                 LOGICAL * 1 CDFLAG, CLSMAP, CSET1, OBJMAP, PHASE1, PHASE2, POLNM1,           SUP00510
                     1 PRSTAT                                                                         SUP00520
                C                                                                                     SUP00530
                CCCC                                                                                  SUP00540
                CCCC                                                                                  SUP00550
                CCCC                                                                                  SUP00560
                CCCC                                                                                  SUP00570
                C LOCAL VARIABLE DEFINITION                                                           SUP00580
                C                                                                                     SUP00590
   0015                 REAL * 4 RWORK(60)                                                            SUP00600
                C                                                                                     SUP00610
   0016                 INTEGER * 4 SUPLST(12), TAPLST(4), CELLST(2), ANNLST, OPTLST,                 SUP00620
                     1 PRNLST(3), CRDLST, IWORK(60)                                                   SUP00630
                C                                                                                     SUP00640
   0017                 LOGICAL * 1 LWORK(1),LSYM(1)                                                  SUP00650
                C                                                                                     SUP00660
   0018                 EQUIVALENCE (IWORK(1),LWORK(1),RWORK(1)),(LSYM(1),SYM(1))                     SUP00670
                C                                                                                     SUP00680
   0019                 DATA SUPLST/'RESU','INTE','CELL','ANNE','OPTI','PRIN','CLAS',                 SUP00690
                     1 'CARD','SYMB','CHAN','DATA','END '/                                           SUP00700
   0020                 DATA TAPLST/'TAPE','FILE','INIT','DISK'/                                      SUP00710
   0021                 DATA CELLST/'SIZE','SELE'/                                                    SUP00720
   0022                 DATA ANNLST/'THRE'/, OPTLST/'INTE'/,CRDLST/'READ'/                            SUP00730
   0023                 DATA PRNLST/'SING','CLAS','STAT'/                                             SUP00740
                C                                                                                     SUP00750
                C INITIALIZATION                                                                      SUP00760
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 FORTRAN IV G LEVEL  20.7              SECRDR          DATE = 77129        15018006              PAGE 0002
FILE SECRDR

                C                                                                                     SUP00770
   0024                 STOPFG = 0                                                                    SUP00780
   0025                 OUTPUT = 0                                                                    SUP00790
   0026                 SYMCNT = 0                                                                    SUP00800
   0027                 NOPOOL = 0                                                                    SUP00810
   0028                 CSELEC = 0.                                                                   SUP00820
   0029                 CELWTH = 0                                                                    SUP00830
   0030                 OPTINT = 0                                                                    SUP00840
   0031                 ROTAPE = -1                                                                   SUP00850
   0032                 ROFILE = -1                                                                   SUP00860
   0033                 ROUNIT = 0                                                                    SUP00870
   0034                 INTTAP = -1                                                                   SUP00880
   0035                 INTFIL = -1                                                                   SUP00890
   0036                 INTENT = 0                                                                    SUP00900
   0037                 THRES = 0.0                                                                   SUP00910
   0038                 NOFET3 = 0                                                                    SUP00920
   0039                 DO 20 I = 1, 30                                                               SUP00930
   0040                 CSEL1(I) = 0                                                                  SUP00940
   0041                 FETVC3(I) = 0                                                                 SUP00950
   0042                 DO 10 J = 1, 3                                                                SUP00960
   0043                 CSET3(J,I) = -50000.                                                          SUP00970
   0044                 CSET1(J,I) = .FALSE                                                           SUP00980
   0045              10 CONTINUE                                                                      SUP00990
   0046              20 CONTINUE                                                                      SUP01000
   0047                 DO 30 I = 1, 60                                                               SUP01010
   0048                 SYM(I) = SYMTX(I)                                                             SUP01020
   0049                 POLSTK(I) = 0                                                                 SUP01030
   0050                 POLNM1(I) = .TRUE.                                                            SUP01040
   0051                 POLPTR(1,I) = 0                                                               SUP01050
   0052              30 CONTINUE                                                                      SUP01060
   0053                 PHASE1 = .FALSE.                                                              SUP01070
   0054                 PHASE2 = .FALSE.                                                              SUP01080
   0055                 CDFLAG = .FALSE.                                                              SUP01090
   0056                 CLSMAP = .FALSE.                                                              SUP01100
   0057                 OBJMAP = .FALSE.                                                              SUP01110
   0058                 PRSTAT = .FALSE                                                               SUP01120
                C                                                                                     SUP01130
                C BEGIN CONTROL CARD PROCESSING                                                       SUP01140
                C                                                                                     SUP01150
   0059                 IF (CONPUT .EQ. 2) WRITE (TYPEWR,50)                                          SUP01160
   0060                50 FORMAT(' ****  TYPE IN SUPERVISED ECHO CONTROL CARDS    (SECRDR)'          SUP01170
                     1)                                                                               SUP01180
   0061                 ERRCOR = 0                                                                    SUP01190
   0062                 ASSIGN 100 TO GOVEC                                                           SUP01200
   0063                 GO TO GOVEC,(100,1100)                                                        SUP01210
   0064              90 CALL CTLWRD(CARD,CCL,SUPLST,12,CODE,READIN,ERRCOR)                            SUP01220
   0065                 IF (CODE .EQ. 11) SPARE(2) = 1                                                SUP01230
   0066                 IF (ERRCOR .EQ. 4) CALL RTMAIN                                                SUP01240
   0067                 IF (ERRCOR .EQ. 2) CALL EAPRNT (139,'STOP')                                   SUP01250
   0068                 GO TO (200,300,400,500,600,700,800,850,900,1000,1100,1050),CODE               SUP01260
                C                                                                                     SUP01270
                C ERROR ON CONTROL CARD                                                               SUP01280
                C                                                                                     SUP01290
   0069              110 WRITE (TYPEWR,9110) CARD                                                     SUP01300
   0070             9110 FORMAT(9X,20A4)                                                             SUP01310
   0071              115 CALL ERPRNT (ERRNUM,'GO')                                                   SUP01320
   0072              120 IF (ERRCOR .NE. 3) ERRCOR = 1                                               SUP01330
   0073                  GO TO 100                                                                   SUP01340
                C                                                                                     SUP01350
                C RESULTS CARD                                                                        SUP01360
                C                                                                                     SUP01370
   0074              200 ENTRY = 2                                                                   SUP01380
   0075                  GO TO 310                                                                   SUP01390
                C                                                                                     SUP01400
                C INTERMEDIATE TAPE CARD                                                              SUP01410
                C                                                                                     SUP01420
   0076              300 ENTRY = 1                                                                   SUP01430
   0077              310 LSIZE = 2 + ENTRY                                                           SUP01440
   0078              315 IF (COL .EQ. 72) GO TO 90                                                   SUP01450
   0079                  CALL CTLPRM (CARD, COL, TAPLST, 4, CODE, &120)                              SUP01460
   0080                  GO TO (320,330,340,350), CODE                                               SUP01470
                C                                                                                     SUP01480
                C TAPE SPECIFICATION                                                                  SUP01490
                C                                                                                     SUP01500
   0081              320 VECSZ = 1                                                                   SUP01510
   0082                  CALL IVAL (CARD,COL,IWORK,VECSZ,&321)                                       SUP01520
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 FORTRAN IV G LEVEL  20.7              SECRDR&          DATE = 77129        15018006          PAGE 0003
FILE SECRDR
0083                   IF (VECSZ .EQ. 0) GO TO 321                                          $UP01530
0084                   IF (ENTRY .EQ. 1) INITAP = IWORK(1)                                  $UP01540
0085                   IF (ENTRY .EQ. 2) ROTAPE = IWORK(1)                                  $UP01550
0086                   GO TO 315                                                            $UP01560
                  C                                                                         $UP01570
                  CC ERROR ON TAPE SPECIFICATION                                            $UP01580
                  C                                                                         $UP01590
                                                                                            $UP01600
0087                321 WRITE (TYPEWR,9348) CARD                                            $UP01610
0088                    WRITE (PRNTR, 9348) CARD                                            $UP01620
0089               9348 FORMAT(/32X,20A4//7X,'E***  ERROR IN TAPE OR FILE SPECIFICATION - TSUP01630
                     1YPE CORRECT CARD    (SECRDR)*')                                     $UP01640
0090                    GO TO 120                                                           $UP01650
                  C                                                                         $UP01660
                  CC FILE SPECIFICATION                                                     $UP01670
                  C                                                                         $UP01680
0091                330 VECSZ = 1                                                           $UP01690
0092                    CALL FVAL(CARD,COL,IWORK,VECSZ,&321)                                $UP01700
0093                    IF (VECSZ .EQ. 0) GO TO 321                                         $UP01710
0094                    IF (ENTRY .EQ. 1) INTFIL = IWORK(1)                                 $UP01720
0095                    IF (ENTRY .EQ. 2) ROFILE = IWORK(1)                                 $UP01730
0096                    GO TO 315                                                           $UP01740
                  C                                                                         $UP01750
                  CC INITIALIZE REQUEST                                                     $UP01760
                  C                                                                         $UP01770
0097                340 IF (ENTRY .EQ. 1) RQINT = 1                                         $UP01780
0098                    IF (ENTRY .EQ. 2) RQINIT = 1                                        $UP01790
0099                    GO TO 315                                                           $UP01800
                  C                                                                         $UP01810
                  CC RESULTS DISK                                                           $UP01820
                  C                                                                         $UP01830
0100                350 OUTPUT = CLASSR                                                     $UP01840
0101                    GO TO 315                                                           $UP01850
                  C                                                                         $UP01860
                  CC CELL CARD                                                              $UP01870
                  C                                                                         $UP01880
0102                400 IF (COL .EQ. 72) GO TO 90                                           $UP01890
0103                    CALL CTLPRM (CARD, COL, CELLST, 2, CODE, &120)                      $UP01900
0104                    GO TO (410,420), CODE                                               $UP01910
                  C                                                                         $UP01920
                  CC CELL SIZE                                                              $UP01930
                  C                                                                         $UP01940
0105                410 VECSZ = 1                                                           $UP01950
0106                    CALL FVAL(CARD,COL,IWORK,VECSZ,&411)                                $UP01960
0107                    CELWTH = IWORK(1)                                                   $UP01970
0108                    GO TO 400                                                           $UP01980
                  C                                                                         $UP01990
                  CC ERROR                                                                  $UP02000
                  C                                                                         $UP02010
0109                411 WRITE (TYPEWR,9411) CARD                                            $UP02020
0110                    WRITE (PRNTR,9411) CARD                                             $UP02030
0111               9411 FORMAT(/9X,20A4//7X,'E***  ERROR IN PARAMETER VALUE SPECIFICATION $UP02040
                     1 - TYPE CORRECT CARD    (SECRDR)*')                                 $UP02050
0112                    GO TO 120                                                           $UP02060
                  C                                                                         $UP02070
                  CC CELL SELECTION PARM                                                    $UP02080
                  C                                                                         $UP02090
0113                420 VECSZ = 1                                                           $UP02100
0114                    CALL FVAL(CARD,COL,RWORK,VECSZ,&411)                                $UP02110
0115                    CSELEC = RWORK(1)                                                   $UP02120
0116                    GO TO 400                                                           $UP02130
                  C                                                                         $UP02140
                  CC ANNEXATION CARD                                                        $UP02150
                  C                                                                         $UP02160
0117                500 IF (COL .EQ. 72) GO TO 90                                           $UP02170
0118                    CALL CTLPRM(CARD,COL,ANNLST,1,CODE,&120)                            $UP02180
0119                    VECSZ = 1                                                           $UP02190
0120                    CALL FVAL(CARD,COL,RWORK,VECSZ,&411)                                $UP02200
0121                    IF (VECSZ .EQ. 0) GO TO 411                                         $UP02210
0122                    THRES = RWORK(1)                                                    $UP02220
0123                    GO TO 500                                                           $UP02230
                  C                                                                         $UP02240
                  CC OPTIONS CARD                                                           $UP02250
                  C                                                                         $UP02260
0124                600 IF (COL .EQ. 72) GO TO 90                                           $UP02270
0125                    CALL CTLPRM(CARD,COL,OPTLST,1,CODE,&120)                            $UP02280
0126                    OPTINT = 1
```

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 FORTRAN IV G LEVEL  20 7              SECRDR&          DATE = 77129        15018006          PAGE 0004
FILE SECRDR
0127                    GO TO 600                                                           $UP02290
                  C                                                                         $UP02300
                  CC PRINT CARD                                                             $UP02310
                  C                                                                         $UP02320
0128                700 IF (COL .EQ. 72) GO TO 90                                           $UP02330
0129                    CALL CTLPRM (CARD,COL,PRNLST,3,CODE,&120)                           $UP02340
0130                    IF (CODE .EQ. 1) CBJMAP = .TRUE.                                    $UP02350
0131                    IF (CODE .EQ. 2) CLSMAP = .TRUE.                                    $UP02360
0132                    IF (CODE .EQ. 3) PASTAT = .TRUE.                                    $UP02370
0133                    GO TO 700                                                           $UP02380
                  C                                                                         $UP02390
                  CC CLASSES CARD                                                           $UP02400
                  C                                                                         $UP02410
0134                800 CALL POLSCN (POLNAM,POLPTR,POLSTK,POLNMI,NOPOOL,STKPTR,COL,CODE,  $UP02420
                     1 &810)                                                              $UP02430
0135                    GO TO 90                                                            $UP02440
                  C                                                                         $UP02450
                  CC ERROR ON CLASSES CARD                                                  $UP02460
                  C                                                                         $UP02470
0136                810 STOPFG = 1                                                          $UP02480
0137                    CALL ERPRNT (341,'GOTO',&90)                                        $UP02490
                  C                                                                         $UP02500
                  CC CARDS READSTATS                                                        $UP02510
                  C                                                                         $UP02520
0138                850 IF (COL .EQ. 72) GO TO 90                                           $UP02530
0139                    CALL CTLPRM(CARD,COL,'READ',1,CODE,&120)                            $UP02540
0140                    CDFLAG = .TRUE.                                                     $UP02550
0141                    GO TO 850                                                           $UP02560
                  C                                                                         $UP02570
                  CC SYMBOLS CARD                                                           $UP02580
                  C                                                                         $UP02590
0142                900 I = 34                                                              $UP02600
0143                    CALL SCOVAL(CARD,COL,WORK,I,&940)                                   $UP02610
0144                    K = SYMCNT + 1                                                      $UP02620
0145                    IF (K .GT. 60) GO TO 950                                            $UP02630
0146                902 DO 905 J = 1,I                                                      $UP02640
0147                905 LSYM(ISYMCNT+J)*4) = LWORK(4*J-3)                                   $UP02650
0148                    SYMCNT = K                                                          $UP02660
0149                    GO TO 90                                                            $UP02670
0150                940 ERRNUM = 447                                                        $UP02680
0151                    GO TO 110                                                           $UP02690
                  C                                                                         $UP02700
                  CC TOO MANY SYMBOLS SPECIFIED                                             $UP02710
                  C                                                                         $UP02720
0152                950 WRITE (TYPEWR,9950)K                                                $UP02730
0153                    WRITE(PRNTR,9950)K                                                  $UP02740
0154               9950 FORMAT(' 10073  YOU HAVE ENTERED',I3,' SYMBOLS. THE MAXIMUM ALLOWESUP02750
                     1D IS 60.',/9X,'EXCESS SYMBOLS WILL NOT BE USED    (SECRDR)')       $UP02760
0155                    I = I - (K-60)                                                      $UP02770
0156                    GO TO 902                                                           $UP02780
                  C                                                                         $UP02790
                  CC CHANNELS CARD                                                          $UP02800
                  C                                                                         $UP02810
0157               1000 CALL CHANEL(CARD,COL,NCR,CSEL3,CSET3,FETVC3,&1070)                  $UP02820
0158                    DO 1060 I = 1,3                                                     $UP02830
0159                    DO 1060 J = 1,30                                                    $UP02840
0160                1060 IF (CSET3(I,J) .NE. -50000 ) CSET1(I,J) = TRUE.                    $UP02850
0161                    NOFET3 = NCR                                                        $UP02860
0162                    GO TO 90                                                            $UP02870
0163                1070 ERRNUM = 171                                                       $UP02880
0164                    GO TO 110                                                           $UP02890
                  C                                                                         $UP02900
                  CC DATA OR END CARD                                                       $UP02910
                  C                                                                         $UP02920
0165                1050 SPARE(2) = 1                                                       $UP02930
0166                1100 IF (STOPFG .EQ. 1) CALL RTMAIN                                     $UP02940
                  C                                                                         $UP02950
                  C CHECK IF NUMBER OF CHAN GT 0                                            $UP02960
                  C                                                                         $UP02970
0167                    IF (NOFET3 .GT. 0) GO TO 1120                                       $UP02980
0168                    ERRNUM = 343                                                        $UP02990
0169                    ASSIGN 1100 TO GOVEC                                                $UP03000
0170                    ERRCOR = 3                                                          $UP03010
0171                    GO TO 115                                                           $UP03020
                  C                                                                         $UP03030
                  C CELL SIZE GT 0 IF SPECIFIED                                             $UP03040
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 FORTRAN IV G LEVEL 20 7              SECRDR&          DATE = 77129          15018006              PAGE 0005
FILE SECRDR

                      C                                                                                SUP03050
 0172                 1120 IF (CELWTH .GE. 2) GO TO 1145                                               SUP03060
 0173                      CELWTH = 2                                                                  SUP03070
 0174                      WRITE (TYPEWR,91120)                                                        SUP03080
 0175                      WRITE (PRNTR,91120)                                                         SUP03090
 0176                 91120 FORMAT(' E***  CELL SIZE MUST BE GREATER THAN OR EQUAL TO 2 - DEFASUP03100
                     1ULT OF 2 ASSUMED  (SECRDR)')                                                    SUP03110
 0177                      GO TO 1145                                                                  SUP03120
 0178                 1125 ASSIGN 1100 TO GOVEC                                                        SUP03130
 0179                      ERRCOR = 1                                                                  SUP03140
 0180                      GO TO 100                                                                   SUP03150
                      C                                                                               SUP03160
                      C BOTH MAPS                                                                     SUP03170
                      C                                                                               SUP03180
 0181                 1145 IF (.NOT. CLSMAP  OR. .NOT  DBJMAP) GO TO 1150                              SUP03190
 0182                      WRITE (TYPEWR,91145)                                                        SUP03200
 0183                      WRITE (PRNTR,91145)                                                         SUP03210
 0184                 91145 FORMAT(' E***  BOTH SINGULAR CELL AND CLASSIFICATION MAPS REQUESTESUP03220
                     1D - ONLY SINGULAR CELL MAP'/9X,'WILL BE PRODUCED    (SECRDR)')                  SUP03230
 0185                      CLSMAP = .FALSE.                                                            SUP03240
                      C                                                                               SUP03250
                      C*****************************************************************************SUP03260
                      C                                                                               SUP03270
                      C BEGIN TAPE PARAMETER CHECKING FOR RESULTS AND INTERMEDIATE TAPE               SUP03280
                      C                                                                               SUP03290
                      C*****************************************************************************SUP03300
                      C                                                                               SUP03310
 0186                 1150 IF (OPTINT .NE. 0) PHASE2 = .TRUE.                                          SUP03320
 0187                      IF (OPTINT .EQ. 0 .AND.ROTAPE .EQ. -1.AND OUTPUT.EQ.0) PHASE1 =           SUP03330C
                     1 .TRUE.                                                                         SUP03340
 0188                      IF(OPTINT.NE 0.OR (ROTAPE.EQ -1.AND OUTPUT.EQ 0))                           SUP03350
                     1 GO TO 1151                                                                     SUP03360
 0189                      PHASE1 = .TRUE.                                                             SUP03370
 0190                      PHASE2 = .TRUE                                                              SUP03380
 0191                 1151 CONTINUE                                                                    SUP03390
                      C                                                                               SUP03400
                      C CSELEC GE 0                                                                   SUP03410
                      C                                                                               SUP03420
 0192                 1130 IF (CSELEC .GE. 0.0 .OR..NOT PHASE1) GO TO 1140                             SUP03430
 0193                      WRITE (TYPEWR,91130)                                                        SUP03440
 0194                      WRITE (PRNTR,91130)                                                         SUP03450
 0195                 91130 FORMAT(' E***  CELL SELECTION PARAMETER MUST BE GREATER THAN OR */SSUP03460C
                     19X,'EQUAL TO ZERO - TYPE CORRECT CARD    (SECRDR)')                             SUP03470
 0196                      GO TO 1125                                                                  SUP03480
                      C                                                                               SUP03490
                      C CHECK FOR ANN GT 0                                                            SUP03500
                      C                                                                               SUP03510
 0197                 1140 IF (THRES .GT. 0.0 .OR  .NOT.PHASE2) GO TO 1152                             SUP03520
 0198                      WRITE(TYPEWR,91140)                                                         SUP03530C
 0199                      WRITE(PRNTR,91140)                                                          SUP03540C
 0200                 91140 FORMAT(' E***  ANNEXATION THRESHOLD MUST BE NON-NEGATIVE.'                 SUP03550C
                     1 /8X,'TYPE A CORRECTED ANNEXATION THRESHOLD CARD   (SECRDR)')                   SUP03560C
 0201                      GO TO 1125                                                                  SUP03570C
                      C                                                                               SUP03580
                      C TAPE PARAMS                                                                   SUP03590
                      C                                                                               SUP03600
 0202                 1152 IF(PHASE1.AND PHASE2)GO TO 1600                                             SUP03610
 0203                      IF (INITAP .NE  -1) GO TO 1155                                              SUP03620C
 0204                      WRITE(TYPEWR,91150)                                                         SUP03630
 0205                      WRITE(PRNTR,91150)                                                          SUP03640
 0206                 91150 FORMAT(' E***  NO INTERMEDIATE TAPE SUPPLIED FO',                          SUP03650
                     1'R OPTIONS INTERMEDIATE.'/8X,'TYPE IN INTERMEDIATE CARD    (SECRDRSUP03660C
                     2)')                                                                             SUP03670C
 0207                      GO TO 1125                                                                  SUP03680
                      C                                                                               SUP03690
                      C CHECK FOR INTERMEDIATE FILE OR INIT                                           SUP03700
                      C                                                                               SUP03710
 0208                 1155 IF (INTFIL .NE. -1  OR. INTINT .NE  0) GO TO 1560                           SUP03720
 0209                      WRITE(PRNTR,91155)                                                          SUP03730
 0210                      WRITE(TYPEWR,91155)                                                         SUP03740
 0211                 91155 FORMAT(' E***  INTERMEDIATE FILE OR INITIALIZE MUST BE SPECIFIED 'SUP03750C
                     1/8X,'TYPE ADDITIONAL INTERMEDIATE CARD    (SECRDR)')                            SUP03760C
 0212                      GO TO 1125                                                                  SUP03770
                      C                                                                               SUP03780
                      C CHECK FOR INTERMEDIATE TAPE FOR OUTPUT AND BOTH FILE AND INIT                 SUP03790
                      C                                                                               SUP03800
```

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 FORTRAN IV G LEVEL 20 7              SECRDR&          DATE = 77129          15018006              PAGE 0006
FILE SECRDR

 0213                 1560 IF (.NOT.PHASE1 .OR. INTFIL  EQ. -1 .OR. INTINT  EQ. 0)                    SUP03810
                     1 GO TO 1600                                                                     SUP03820
 0214                      WRITE(TYPEWR,91560)                                                         SUP03830
 0215                      WRITE(PRNTR,91560)                                                          SUP03840
 0216                 91560 FORMAT(' I0000  BOTH FILE AND INITIALIZE REQUESTED FOR INTERMEDIATSUP03850C
                     1E TAPE -'/8X,'FILE REQUEST IGNORED    (SECRDR)')                                SUP03860
 0217                      INTFIL = -1                                                                 SUP03870
                      C                                                                               SUP03880
                      C CHECK FOR BOTH INT AND RESULTS                                                SUP03890
                      C                                                                               SUP03900
 0218                 1600 IF((INITAP.EQ.-1.OR (RQTAPE.EQ.-1.AND OUTPUT EQ 0)).OR.OPTINT NE.SUP03910
                     1 0)GO TO 2100                                                                   SUP03920
 0219                      WRITE(TYPEWR,92000)                                                         SUP03930
 0220                      WRITE(PRNTR,92000)                                                          SUP03940
 0221                 92000 FORMAT(' E***  BOTH INTERMEDIATE TAPE AND RESULTS LOCATION SPECIFI SUP03950
                     1ED WITHOUT OPTIONS'/9X,'INTERMEDIATE - JOB TERMINATED    (SECRDR)'SUP03960
                     2)                                                                               SUP03970C
 0222                      CALL RTMAIN                                                                 SUP03980
                      C                                                                               SUP03990
                      C SEE IF EITHER TAPE WAS REQUESTED                                              SUP04000
                      C                                                                               SUP04010
 0223                 2100 IF (INITAP.NE -1 OR RQTAPE NE.-1.OR OUTPUT NE 0.OR.OPTINT.EQ.1)            SUP04020
                     1GO TO 2200                                                                      SUP04030
 0224                      WRITE(TYPEWR,92100)                                                         SUP04040
 0225                      WRITE(PRNTR,92100)                                                          SUP04050
 0226                 92100 FORMAT(' E***  EITHER INTERMEDIATE TAPE OR RESULTS LOCATION MUST BSUP04060
                     1E SPECIFIED WITHOUT'/8X, 'OPTIONS INTERMEDIATE - TYPE IN ADDITIONASUP04070
                     2L CARD    (SECRDR)')                                                            SUP04080
 0227                      GO TO 1125                                                                  SUP04090
                      C                                                                               SUP04100
                      C CHECK FOR RESULTS IF NEEDED                                                   SUP04110
                      C                                                                               SUP04120
 0228                 2200 IF (.NOT. PHASE2) GO TO 4000                                               SUP04130
 0229                      IF (RQTAPE.NE.-1.OR.OUTPUT.NE 0) GO TO 3050                                 SUP04140
 0230                      WRITE(TYPEWR,93000)                                                         SUP04150
 0231                      WRITE(PRNTR,93000)                                                          SUP04160
 0232                 93000 FORMAT(' E***  NO RESULTS DESTINATION SPECIFIED - TYPE IN RESULTS SUP04170
                     1 CARD    (SECRDR)')                                                             SUP04180
 0233                      GO TO 1125                                                                  SUP04190
                      C                                                                               SUP04200
                      C CHECK FOR FILE AND INIT                                                       SUP04210
                      C                                                                               SUP04220
 0234                 3050 IF (RQFILE .EQ. -1 .AND. RQINIT .EQ  0) GO TO 3075                          SUP04230
 0235                      WRITE(TYPEWR,93050)                                                         SUP04240
 0236                      WRITE(PRNTR,93050)                                                          SUP04250
 0237                 93050 FORMAT(' E***  EITHER RESULTS FILE OR INITIALIZE MUST BE',                 SUP04260
                     1 ' REQUESTED '/8X,'TYPE IN ADDITIONAL RESULTS CARD    (SECRDR)')               SUP04270
 0238                      GO TO 1125                                                                  SUP04280
                      C                                                                               SUP04290
                      C CHECK FOR BOTH FILE AND INIT SPECIFIED ON RESULTS REQUEST                     SUP04300
                      C                                                                               SUP04310
 0239                 3075 IF (RQFILE .EQ. -1 .OR. RQINIT .EQ. 0) GO TO 3100                           SUP04320
 0240                      WRITE(TYPEWR,93075)                                                         SUP04330
 0241                      WRITE(PRNTR,93075)                                                          SUP04340
 0242                 93075 FORMAT(' I0000  BOTH FILE AND INTIALIZE REQUESTED FOR RESULTS TAPESUP04350
                     1 -'/8X,'FILE REQUEST IGNORED    (SECRDR)')                                      SUP04360
 0243                      RQFILE = -1                                                                 SUP04370
                      C                                                                               SUP04380
                      C CHECK FOR TAPE PARAM AND DISK                                                 SUP04390
                      C                                                                               SUP04400
 0244                 3100 IF (OUTPUT .EQ. 0) GO TO 4000                                              SUP04410
 0245                      IF (RQTAPE .EQ. -1.AND.RQFILE.EQ -1.AND.RQINIT.EQ 0) GO TO 4000           SUP04420
 0246                      WRITE (TYPEWR,93100)                                                        SUP04430C
 0247                      WRITE (PRNTR,93100)                                                         SUP04440
 0248                 93100 FORMAT(' E***  BOTH RESULTS TAPE PARAMETERS AND DISK SPECIFIED - F SUP04450C
                     1UNCTION TERMINATED    (SECRDR)')                                               SUP04460
 0249                      CALL RTMAIN                                                                 SUP04470
 0250                 4000 IF (OUTPUT .EQ  0) OUTPUT = MAPTAP                                          SUP04480
 0251                      IF (CHKOUT) RETURN                                                          SUP04490
                      C                                                                               SUP04500
                      C MOUNT TAPES  - RESULT                                                         SUP04510
 0252                      IF (.NOT.PHASE2 .OR. OUTPUT .EQ. CLASSR) GO TO 4200                         SUP04520
 0253                      IF (RQINIT  EQ  1) RQFILE = 0                                               SUP04530
 0254                      CALL MTAPE(RQTAPE,RQFILE,1)                                                 SUP04540
 0255                      IF (RQFILE .GE. 0) GO TO 4200                                               SUP04550
                                                                                                       SUP04560
```

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 FORTRAN IV G LEVEL  20.7              SECRDR6           DATE = 77129        15018006            PAGE 0007
FILE SECRDR
   0256                RQFILE = IABS(RQFILE)                                                    SUP04570
   0257                CARCOR = 1                                                               SUP04580
   0258                ASSIGN 1100 TO GOVEC                                                     SUP04590
   0259                GO TO 100                                                                SUP04600
                     C                                                                        SUP04610
                     C INTERMEDIATE TAPE                                                      SUP04620
                     C                                                                        SUP04630
   0260               4200 IF (PHASE1 .AND. PHASE2) GO TO 4300                                 SUP04640
   0261                MODE = 1                                                                SUP04650
   0262                IF (PHASE2) MODE = -2                                                   SUP04660
   0263                IF (INTIN .NE. 0 .AND. PHASE1) INTFIL = 0                               SUP04670
   0264                CALL MTAPE(INTTAP,INTFIL,MODE)                                          SUP04680
   0265                IF(INTFIL.GE.01 GO TO 4300                                              SUP04690
   0266                INTFIL = IABS(INTFIL)                                                   SUP04700
   0267                GO TO 4100                                                              SUP04710
                     C                                                                        SUP04720
                     C OPTIONS                                                                SUP04730
                     C                                                                        SUP04740
   0268               4300 IF (INTFIL .EQ. 0) INTFIL = 1                                       SUP04750
   0269                IF (RQFILE .EQ. 0) RQFILE = 1                                           SUP04760
   0270                WRITE (PRNTR,94300)                                                     SUP04770
   0271              94300 FORMAT('0 YOU HAVE SELECTED THE FOLLOWING SUPERVISED ECHO OPTIONS'SUP04780
                    1/)                                                                       SUP04790
   0272                IF (CDFLAG) WRITE(PRNTR,94301)                                          SUP04800
   0273              94301 FORMAT(5X,'USE STATISTICS FROM CONTROL CARD DECK')                  SUP04810
   0274                IF (CLSMAP) WRITE(PRNTR,94302)                                          SUP04820
   0275              94302 FORMAT(5X,'PRINT CLASSIFICATION RESULTS MAP')                       SUP04830
   0276                IF (OBJMAP) WRITE(PRNTR,94303)                                          SUP04840
   0277              94303 FORMAT(5X,'PRINT SINGULAR CELL MAP')                                SUP04850
   0278                IF (PHASE1) WRITE(PRNTR,94304)                                          SUP04860
   0279              94304 FORMAT(5X,'PERFORM INITIAL CELL PROCESSING OF AREA')                SUP04870
   0280                IF (PHASE2) WRITE(PRNTR,94305)                                          SUP04880
   0281              94305 FORMAT(5X,'PERFORM CELL ANNEXATION AND PRODUCE CLASSIFICATION RESUSUP04890
                    1LTS')                                                                    SUP04900
   0282                IF (PRSTAT) WRITE(PRNTR,94306)                                          SUP04910
   0283              94306 FORMAT(5X,'PRINT MULTISPECTRAL STATISTICS USED')                    SUP04920
   0284                RETURN                                                                  SUP04930
   0285                END                                                                     SUP04940
```

LARS Program Abstract _____

MODULE IDENTIFICATION

Module Name: SECINT Function Name: SECSUP

Purpose: Initiator routine for Supervised ECHO classifier.

System/Language: CMS/Fortran

Author: P.D. Alenduff Date: 4/27/77

Latest Revisor: Date:

MODULE ABSTRACT

SECINT carries out required initialization of the rest of variables used by SECSUP and finishes reading any data cards as well as the statistics to be used with the processor. In addition to the array allocation performed, some option information is printed and a loop is entered that carries out the desired stages of classification for each area to be classified.

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1. Module Usage

SECINT

CALL SECINT

The program SECINT is called with no arguments. Any variables to be used or changed are contained in common blocks GLOCOM and SECCOM, both required by SECINT. All information required to perform the classification is gathered by SECINT from the appropriate source (ie., statistics and areas to be classified) and array allocation is carried out using variables supplied to common block SECCOM by the control card reader SECRDR. Statistics are reduced by calling REDSAV to save statistics for only classes and channels requested and statistics information is printed by calling SECPRT. Initial records are then written to the output device. A loop is entered and, for each area to be classified, a sequence of tests is performed. If multispectral data is required, the correct run is requested and existance of requested channels is confirmed. Further allocation is performed and SECHO1 is called to perform the needed processing for the area.

2. Internal Description

The first information handled by SECINT is the statistics file. If processing is starting from an intermediate tape, records 1 and 2 are read from the intermediate tape to re-establish information used in initial processing such as channels selected and calibration used, and classes selected and pooling requested. The statistics file is then read from the

tape and written onto the unit SDATA, the statistics file on disk. The next card is checked for an "end" card and if any area description cards are required, the function is terminated.

Otherwise, CLASSX, the storage disk file for all classification areas for this file, is rewound and processing loops until all areas are stored on disk. Some initial allocation is then performed as array storage is set up for the covariance and mean matrices for the entire statistics file on disk. REDSTA transfers the file into memory. CLSCHK and FETCHK then check for fatal errors in selection of pooling and channels. The addresses of reduced arrays for storing only needed information are then computed and REDSAV reduces the information to that required.

Initial records are then produced and written to OUTPUT. The entire statistics-file from SDATA is then transfered to the output file, and SECPRT is called to print the statistics information, if requested, and to produce the record type 4 with covariance and means matrices of the classes. A loop is then started and executed once for each area to be classified. If processing begins with the data type, the correct input run is requested and calibration information is established. If processing begins with an intermediate type, all areas on the tape in this file are used. Field size and the allocation of all other arrays used by SECHO1 are calculated. Then a record type 5, area identification record, is produced and SECHO1 is called once for each area to be processed. When finished, the

final record is written to the output device.

3. Input Description

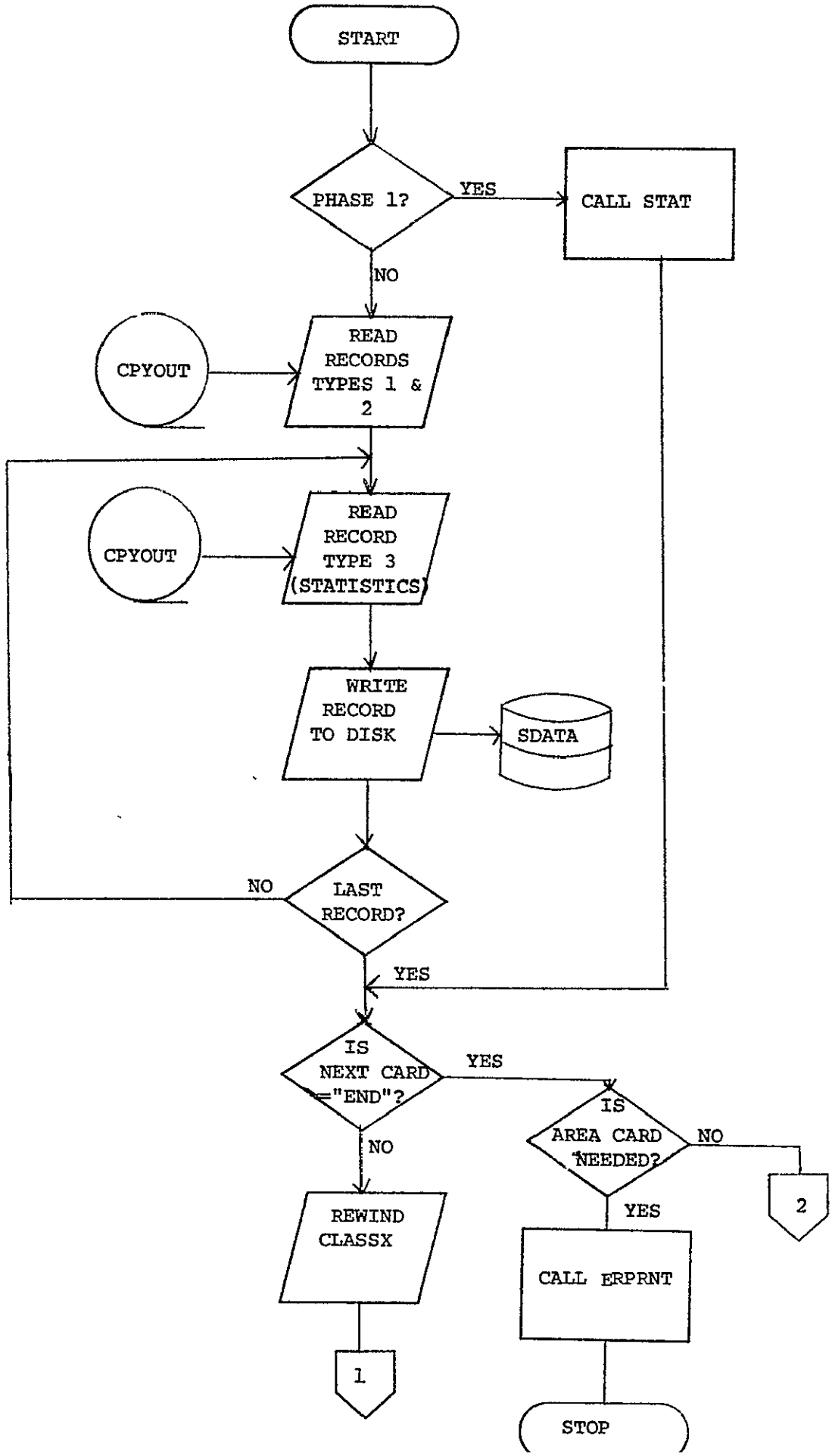
Input cell information for SECINT is read from CPYOUT if an intermediate tape is requested as the starting point of processing. The format is identical to that of a classification results file. SDATA, the statistics file on disk is also read to be copied into the output file. CLASSX, the areas to be classified as stored on disk, is also used to store the list of areas to be processed.

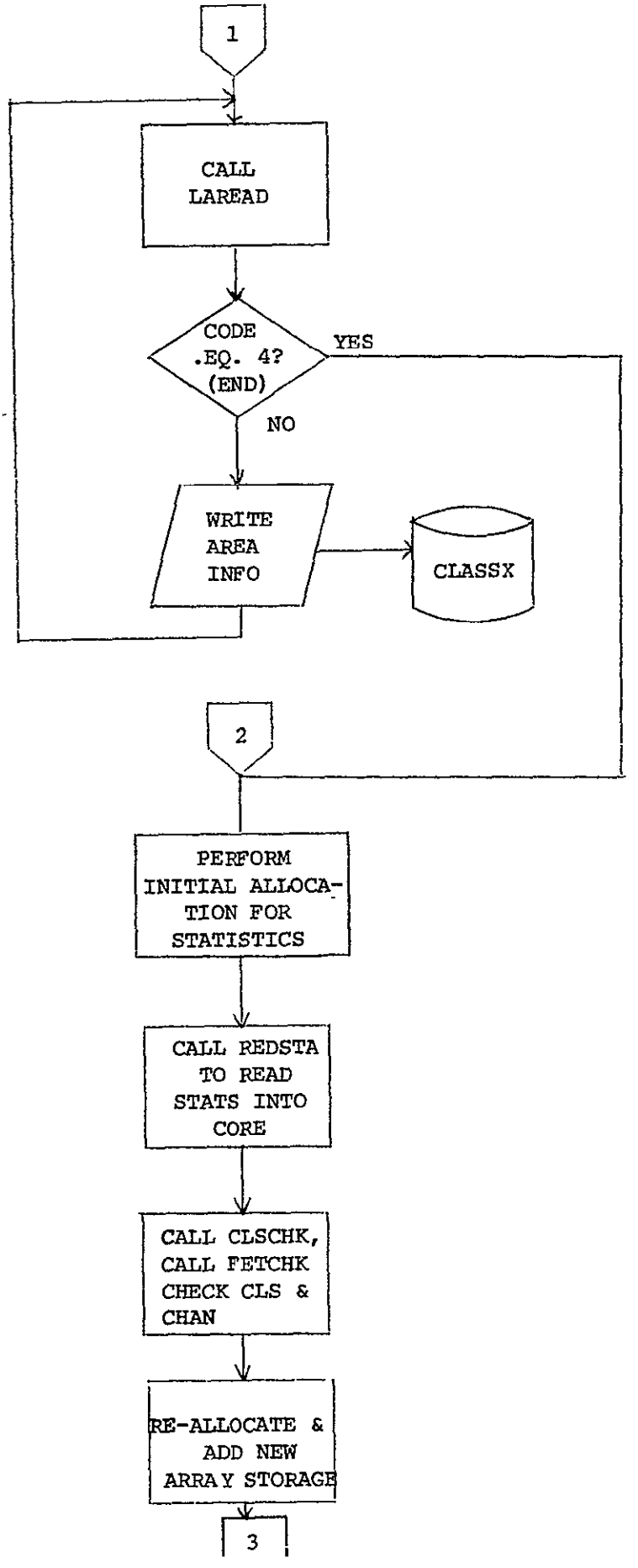
4. Output Description

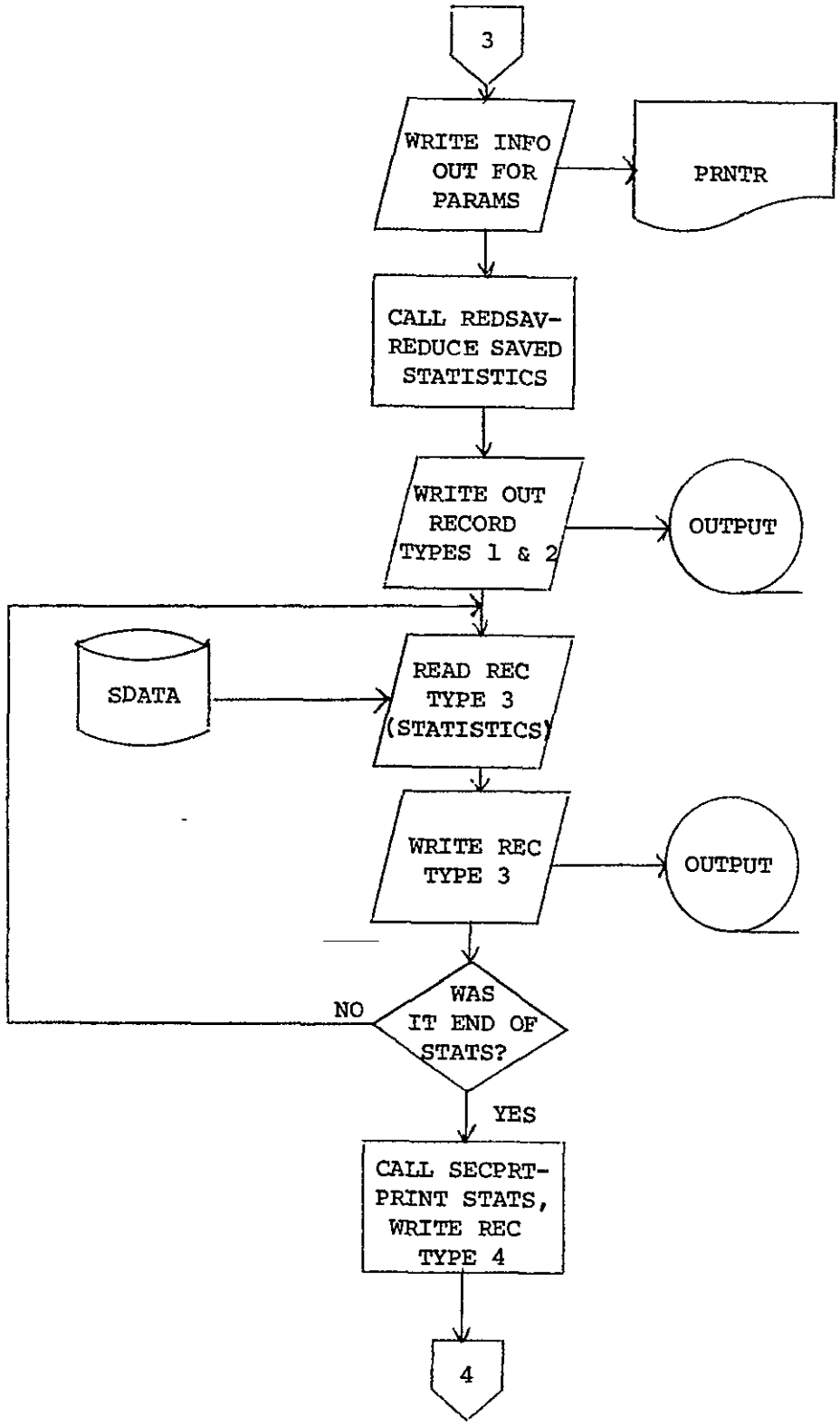
A copy of the statistics file is written to SDATA from the intermediate tape is used as input. CLASSX is written as the list of areas to be classified. The PRNTR is used for messages and output information. The file OUTPUT is the result of processing with the same format as a classification results file.

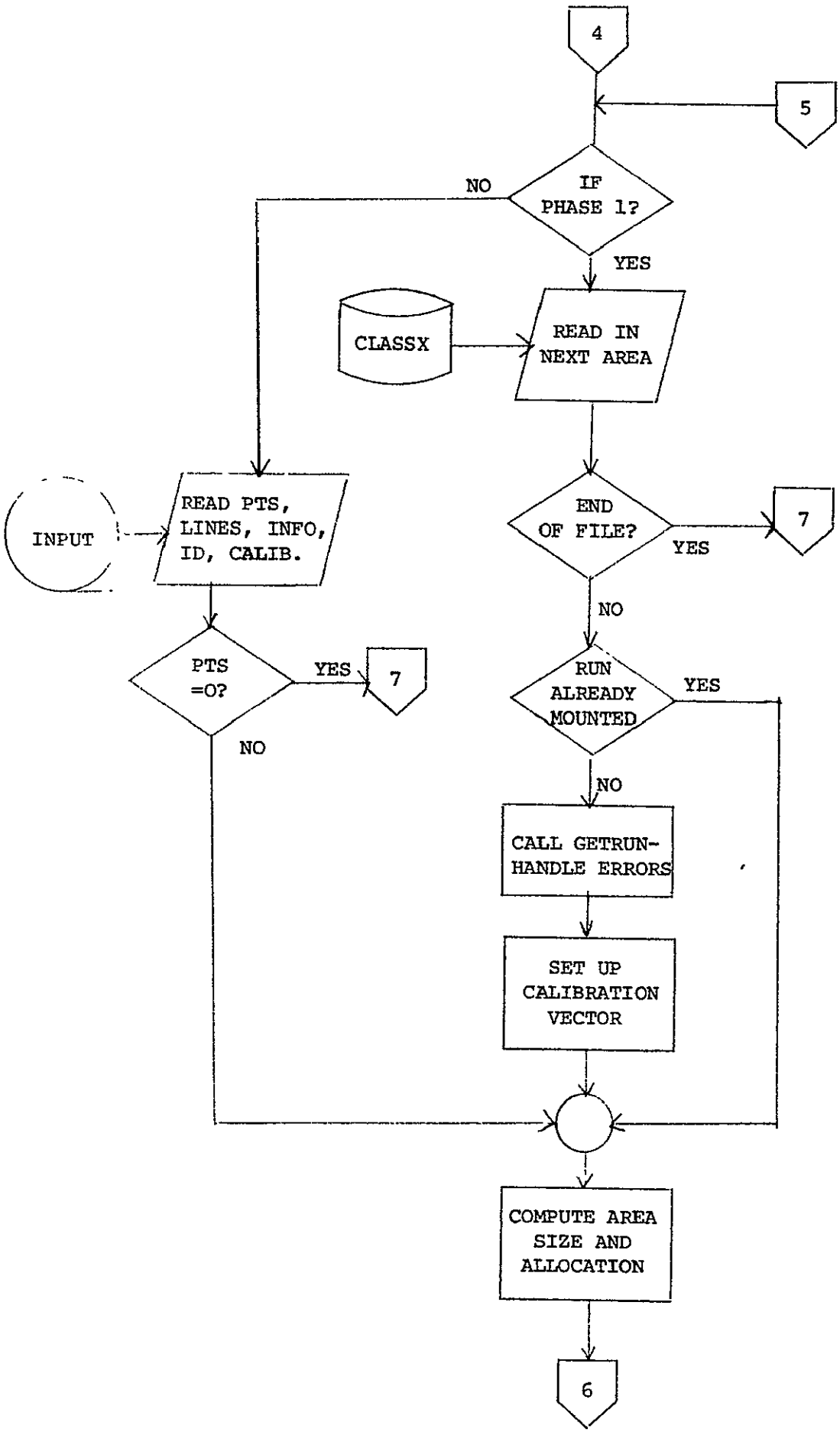
5. Supplemental Information

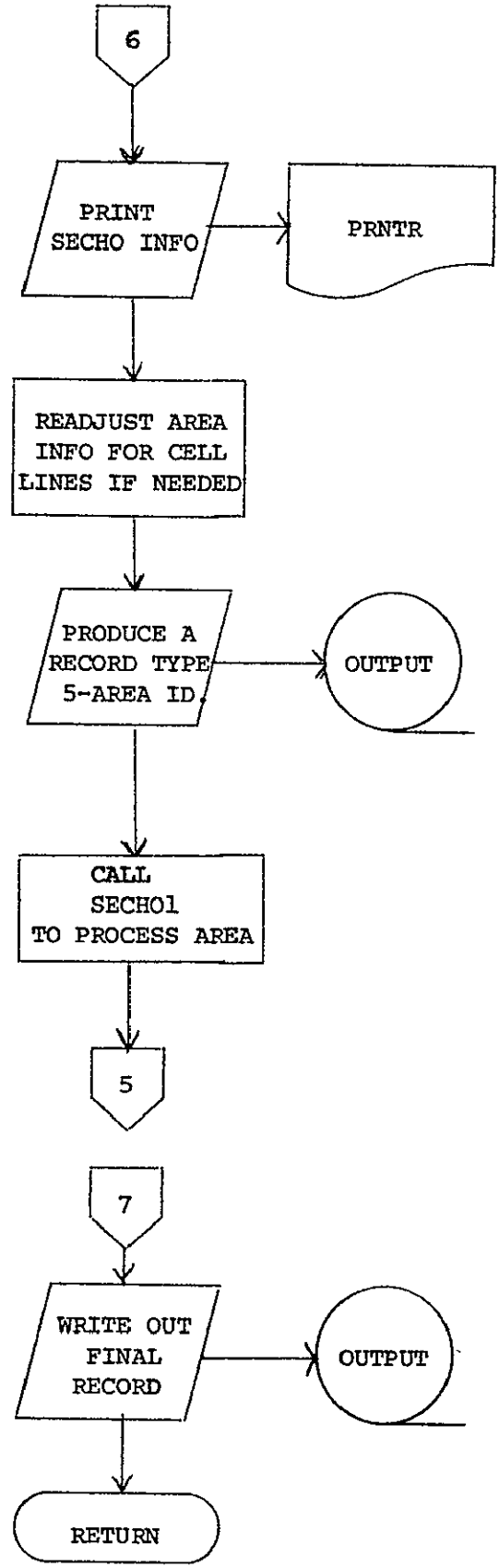
This program uses common blocks GLOCOM and SECCOM. See LARSYS Systems Manual for classification results file format.


START
PHASE 1?
YES
CALL STAT
NO
CPYOUT
READ RECORDS TYPES 1 & 2
CPYOUT
READ RECORD TYPE 3 (STATISTICS)
WRITE RECORD TO DISK
SDATA
NO
LAST RECORD?
YES
IS NEXT CARD ="END"?
YES
IS AREA CARD NEEDED?
NO
2
NO
REWIND CLASSX
YES
CALL ERPRNT
1
STOP


1
CALL LAREAD
CODE .EQ. 4? (END)
YES
NO
WRITE AREA INFO
CLASSX
2
PERFORM INITIAL ALLOCA-TION FOR STATISTICS
CALL REDSTA TO READ STATS INTO CORE
CALL CLSCHK, CALL FETCHK CHECK CLS & CHAN
RE-ALLOCATE & ADD NEW ARRAY STORAGE
3


3
WRITE INFO OUT FOR PARAMS
PRNTR
CALL REDSAV- REDUCE SAVED STATISTICS
WRITE OUT RECORD TYPES 1 & 2
OUTPUT
SDATA
READ REC TYPE 3 (STATISTICS)
WRITE REC TYPE 3
OUTPUT
NO
WAS IT END OF STATS?
YES
CALL SECPRT- PRINT STATS, WRITE REC TYPE 4
4


4
5
IF PHASE 1?
NO
YES
CLASSX
READ IN NEXT AREA
INPUT
READ PTS, LINES, INFO, ID, CALIB.
END OF FILE?
YES
7
NO
PTS =0?
YES
7
NO
RUN ALREADY MOUNTED
YES
NO
CALL GETRUN- HANDLE ERRORS
SET UP CALIBRATION VECTOR
COMPUTE AREA SIZE AND ALLOCATION
6


6
PRINT SECHO INFO
PRNTR
READJUST AREA INFO FOR CELL LINES IF NEEDED
PRODUCE A RECORD TYPE 5-AREA ID.
OUTPUT
CALL SECH01 TO PROCESS AREA
5
7
WRITE OUT FINAL RECORD
OUTPUT
RETURN

FILE SECINT

```
C   SECINT     LARS     XXXX                                                    SEC00010
C                                                                               SEC00020
C*****************************************************************************SEC00030
C                                                                               SEC00040
C PERFORM ECHO SUPERVISED VERSION ON AREA                                       SEC00050
C                                                                               SEC00060
C*****************************************************************************SEC00070
C                                                                               SEC00080
C        WRITTEN  03/4/77 BY P.D. ALENDUFF                                      SEC00090
C                                                                               SEC00100
C*****************************************************************************SEC00110
C                                                                               SEC00120
0001        SUBROUTINE SECINT                                                   SEC00130
0002        IMPLICIT INTEGER * 4 (A-Z)                                          SEC00140
C                                                                               SEC00150
0003        COMMON /GLCCOM/ BLANK, CARD(20), CHKOUT, COPFIL, CLASSR, CLASSX,    SEC00160
           1    CLLSTX, CONPUT, CPYOUT, CRDRDR, CRDSEQ, DATAPE,                 SEC00170
           2    DUPLIP, DUPRUN, ERRMSG, FBPNT,                                  SEC00180
           3    FILESV, FLDBND, HDATA, HEAD(88), ID(200), IMAGEX,               SEC00190
           4    IMARK, KEYBD, MAPTAP, MAXCHA, MAXCLS,                           SEC00200
           5    PAGSIZ, PNCH, POINT, PRESUX, PRNTR, READIN,                     SEC00210
           6    RESTRT, RUNFIL, RUNTAB(10,3),                                   SEC00220
           7    SDATA, SEPARX, SEPTPX, SPARE(10), TEMPAS(30),                   SEC00230
           8    TPSTAT(6), TTFLDX ,TYPEWR,                                      SEC00240
           9    TOP, ARRAY(12500)                                               SEC00250
C                                                                               SEC00260
0004        REAL * 8 ARRAY                                                      SEC00270
0005        REAL * 4 FROCAL(5,30)                                               SEC00280
0006        INTEGER * 4 COMENT(16), DATE(5), HED1(16), HED2(16), TIME(5)        SEC00290
0007        INTEGER * 2 BLANK2                                                  SEC00300
0008        LOGICAL * 4 CHKOUT                                                  SEC00310
0009        LOGICAL * 1 BLANK1                                                  SEC00320
0010        EQUIVALENCE (DATSAV,ID(1)), (CURRUN,ID(3)), (FROCAL(1),ID(51)),     SEC00330
           1        (HED1(1),HEAD(8)), (DATE(1),HEAD(26)), (HED2(1),HEAD(39)),  SEC00340
           2        (TIME(1),HEAD(58)), (COMENT(1),HEAD(72)),                   SEC00350
           3        (MAPSAV,TPSTAT(1)),                                         SEC00360
           4        (SEPSCR,TPSTAT(2)), (DUPIN,TPSTAT(3)), (DASTAT,TPSTAT(4)),  SEC00370
           5        (CCPSER,TPSTAT(5)), (TRAOUT,TPSTAT(6)),                     SEC00380
           6        (BLANK,BLANK2,BLANK1)                                       SEC00390
C                                                                               SEC00400
C                                                                               SEC00410
0011        COMMON /SECCOM/ BUFROZ,CSELEC,CSET1(3,30),CSET3(3,30),THRES,CELSIZ, SEC00420
           1 CELMTH,INFO(17),INPUT, INTTAP, INTFIL, JPTS, LINES, NOCLS, NOFET, SEC00430
           2 NOFET3,NOPOOL,NWCRD,NWORD2, NVR, OUTPUT, POLNAM(2,60), PREFIX(2),  SEC00440
           3 PTS, RQTAPE, RQFILE, SYMCNT, VARSZ3, CSEL(30), CSEL3(30),          SEC00450
           3 FETVEC(30), FETVC3(30), PCLPTR(2,60), POLSTK(60),                  SEC00460
           4 CDFLAG, CLSMAP, CSET1(3,30), OBJMAP, PHASE1, PHASE2, POLNM1(60),   SEC00470
           5 PRSTAT, SYM(60), SYMMTX(60)                                        SEC00480
C                                                                               SEC00490
0012        REAL * 4 CSELEC, CSET, CSET3, THRES                                 SEC00500
C                                                                               SEC00510
0013        INTEGER * 2 CSEL, CSEL3, FETVEC, FETVC3, POLPTR, POLSTK             SEC00520
C                                                                               SEC00530
0014        LOGICAL * 1 CDFLAG, CLSMAP, CSET1, OBJMAP, PHASE1, PHASE2, POLNM1,  SEC00540
           1 PRSTAT                                                             SEC00550
C                                                                               SEC00560
C                                                                               SEC00570
C                                                                               SEC00580
C                                                                               SEC00590
C                                                                               SEC00600
C                                                                               SEC00610
C LOCAL VARIABLE DEFINITION                                                     SEC00620
C                                                                               SEC00630
0015        REAL * 8 BUFFER(6250)                                               SEC00640
0016        REAL*4 WORK(60)                                                     SEC00650
0017        INTEGER * 4 CLSDAT(5), CARD1(19), KEPPTS(60),NOCNT(60),             SEC00660
           1 IWORK(1)                                                           SEC00670
0018        INTEGER * 2 BINFLG                                                  SEC00680
0019        LOGICAL * 1 CHKFLG                                                  SEC00690
0020        EQUIVALENCE (WORK(1),NOCNT(1)),(CARD(1),CARD1(1)),                  SEC00700
           1 (IWORK(1),WORK(1))                                                 SEC00710
C                                                                               SEC00720
0021        DATA IEOS/'EOS '/,END/'END '/                                       SEC00730
C                                                                               SEC00740
0022        INPUT = CPYOUT                                                      SEC00750
0023        AREAFG = 0                                                          SEC00760
```

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

FILE SECINT

```
0024                CALL GTSERL(SERIAL)                                                    SEC00770
0025                IF (PHASE1) GO TO 200                                                  SEC00780
0026                IF (CHKOUT) GO TO 300                                                  SEC00790
                    C                                                                      SEC00800
                    C READ STATISTICS TO DISK FROM INTERMEDIATE TAPE                       SEC00810
                    C                                                                      SEC00820
0027                READ (INPUT,END=9000)I,I,I,I,I,I,SERIAL,MODFLG                         SEC00830
0028                IF (MODFLG .NE. 0) GO TO 105                                           SEC00840
0029                READ (INPUT,END=9000)I,I,NOCLS4,NOFET3,NOFLD,NOPOOL,                   SEC00850
                   1 (FETVC3(I),I=1,NOFET3),(CSEL3(FETVC3(I)),I=1,NOFET3),                 SEC00860
                   2((FRQCAL(1,FETVC3(I)),I=1,NOFET3),(FRQCAL(2,FETVC3(I)),I=1,NOFET3),    SEC00870
                   3 (((PCLNAM(I,J),I=1,2),J=1,NOPCOL),((PCLPTR(I,J),I=1,2),J=1,NOPOOL)    SEC00880
                   4,(PCLSTK(I),I=1,NOCLS4),(CLSDAT(I),I=3,5),CLSDAT(1),CLSDAT(2)          SEC00890
0030                GO TO 110                                                              SEC00900
0031              105 READ (INPUT,END=9000)I,I,NOCLS4,NOFET3,NOFLD,NOPOOL,                 SEC00910
                   1 (FETVC3(I),I=1,NOFET3),(CSEL3(FETVC3(I)),I=1,NOFET3),                 SEC00920
                   2((FRQCAL(1,FETVC3(I)),I=1,NOFET3),(FRQCAL(2,FETVC3(I)),I=1,NOFET3)     SEC00930
                   3,(((PCLNAM(I,J),I=1,2),J=1,NOPCOL),((PCLPTR(I,J),I=1,2),J=1,NOPOOL)    SEC00940
                   4,(PCLSTK(I),I=1,NOCLS4),(WORK(I),I=1,NOPOOL),(CLSDAT(I),I=3,5),        SEC00950
                   5 CLSDAT(1),CLSDAT(2)                                                   SEC00960
0032                CELWTH = IWORK(1)                                                      SEC00970
0033                THRES = WORK(2)                                                        SEC00980
                    C                                                                      SEC00990
                    C READY TO COPY FROM INPUT TAPE TO DISK                                SEC01000
                    C                                                                      SEC01010
0034              110 REWIND SDATA                                                         SEC01020
0035                READ(INPUT,END=9000)I,I,CARD1,CRDSEQ                                   SEC01030
0036                BINFLG = 0                                                             SEC01040
0037                IF (CARD1(11) .EQ. IONE) BINFLG = 1                                    SEC01050
0038                WRITE(SDATA,9110) CARD1,CRDSEQ                                         SEC01060
0039             9110 FORMAT(18A4,I8)                                                      SEC01070
0040              115 READ(INPUT,END=9000) I,I,CARD1,CRDSEQ                                SEC01080
0041                WRITE(SDATA,9115)CARD1,CRDSEQ                                          SEC01090
0042             9115 FORMAT(18A4,I8)                                                      SEC01100
0043                IF (CARD1(1).NE. IEOS) GO TO 115                                       SEC01110
0044                GO TO 300                                                              SEC01120
                    C                                                                      SEC01130
                    C CHECK STATS ON DISK                                                  SEC01140
                    C                                                                      SEC01150
0045              200 CHKFLG = .FALSE.                                                     SEC01160
0046                UNIT = CRDRDR                                                          SEC01170
0047                IF (.NOT.CDFLAG) UNIT = SDATA                                          SEC01180
0048                IF (UNIT .EQ. CRDRDR.OR..NOT.CHKOUT) GO TO 210                         SEC01190
0049                REWIND SDATA                                                           SEC01200
0050                READ(SDATA,9200)I                                                      SEC01210
0051             9200 FORMAT(20A4)                                                         SEC01220
0052                IF (I.NE. IEOS) GO TO 210                                              SEC01230
0053                CHKFLG=.TRUE.                                                          SEC01240
                    C                                                                      SEC01250
                    C STATS ON CARDS OR DISK                                               SEC01260
                    C                                                                      SEC01270
0054              210 CALL STAT(UNIT,NOCLS,NOFLD,NOFET,NUM,BINFLG)                         SEC01280
                    C                                                                      SEC01290
                    C STATS ARE NOW ON DISK - TRANSFER TO CORE                             SEC01300
                    C                                                                      SEC01310
0055              300 REWIND CLASSX                                                        SEC01320
0056                IF (PHASE2.AND..NOT. PHASE1) AREAFG = 1                                SEC01330
0057                IF (CARD(1) .NE. END) GO TO 310                                        SEC01340
0058                IF (PHASE1) CALL ERPRNT(254,'STOP')                                    SEC01350
0059                GO TO 350                                                              SEC01360
                    C                                                                      SEC01370
                    C READ AREA CARDS                                                      SEC01380
                    C                                                                      SEC01390
0060              310 IF (AREAFG .EQ. 1) GO TO 350                                         SEC01400
0061                CALL LAREAD (INFO,CODE,READIN,0,0)                                     SEC01410
0062                IF (CODE .EQ. 4) GO TO 350                                             SEC01420
0063                IF (CODE .NE. 0) CALL ERPRNT(373,'&GOTO',300)                          SEC01430
0064                IF (CHKOUT) GO TO 310                                                  SEC01440
0065                WRITE(CLASSX) INFO                                                     SEC01450
0066                GO TO 310                                                              SEC01460
                    C                                                                      SEC01470
                    C CONTINUE PROCESSING                                                  SEC01480
                    C                                                                      SEC01490
0067              350 VARSIZ = NOFET*(NOFET+1)/2                                           SEC01500
0068                COVAR1 = 1                                                             SEC01510
0069                AVAR1 = COVAR1 + (VARSIZ*NOCLS+1)/2                                    SEC01520
```

```
FILE SECINT
0070                CLSID1 = AVAR1 + (NOFET * NOCLS + 1)/2                                  SEC01530
0071                CATBAS = CLSID1 + NOCLS                                                 SEC01540
0072                CORE = TOP - (DATBAS*8)                                                 SEC01550
0073                IF (CORE .LE. 0) CALL ERPRNT(371,'STOP')                                SEC01560
0074                CALL REDSTA(ARRAY(COVAR1),ARRAY(AVAR1),ARRAY(CLSID1),KEPPTS,            SEC01570
                   1BINFLG,NOCNT,NOCLS,CSET,CSEL,FETVEC,VARSTZ,NOFET)                       SEC01580
C                                                                                          SEC01590
C  STATS ARE IN CORE - CHECK CLASSES AND CHANNELS IF NEEDED                                SEC01600
C                                                                                          SEC01610
C       IF WE JUST GOT THEM OFF TAPE THEN THEY ARE OK                                      SEC01620
C                                                                                          SEC01630
0075                IF (PHASE2.AND..NOT.PHASE1) GO TO 380                                  SEC01640
0076                NO = 0                                                                 SEC01650
0077                N = 0                                                                  SEC01660
0078                CALL CLSCHK(ARRAY(CLSID1),NOCLS,NCPOOL,POLPTR,POLSTK,POLNAM,POLMN1SEC01670
                   1,STKPTR,NO)                                                            SEC01680
0079                CALL FETCHK(MAXCHA,FETVEC,NOFET,NCFET3,FETVC3,CSEL3,CSEL)              SEC01690
0080                IF (NOFET3 .LE. 0) CALL ERPRNT(372,'STOP')                             SEC01700
0081                N = POLPTR(2,NOPOOL)+ POLPTR(1,NOPOOL) - 1                             SEC01710
0082                DO 360 II=1,N                                                          SEC01720
0083              360 NOFLD3 = NCFLD3 + NOCNT(POLSTK(II))                                  SEC01730
C                                                                                          SEC01740
C  ALLOCATE STORAGE AND PRINT DATA                                                         SEC01750
C                                                                                          SEC01760
0084              380 VARSZ3 = NOFET3*(NOFET3+1)/2                                         SEC01770
0085                COVAR3 = CCVAR1                                                        SEC01780
0086                AVAR3 = COVAR3 + (VARSZ3*NCPOOL+1)/2                                   SEC01790
0087                SCRAR3 = AVAR3 + (NOFET3*NCPOOL + 1)/2                                 SEC01800
0088                DETAR3 = SCRAR3 + (NOPOOL+1)/2                                         SEC01810
0089                CONAR3 = DETAR3 + (NCPOOL+1)/2                                         SEC01820
0090                DATBS3 = CONAR3 + (NCPOOL+1)/2                                         SEC01830
0091                END = DATBS3 + (NOFET3*(NOFET3+2)+1)/2                                 SEC01840
0092                CORE = TOP - END*8                                                     SEC01850
0093                IF (CORE .LT.0)CALL ERPRNT(371,'STOP')                                 SEC01860
0094                IF (.NOT. PHASE1) CALL SECRD(ARRAY(COVAR3),ARRAY(AVAR3))               SEC01870
C                                                                                          SEC01880
C  PRINT SUPERVISOR INFORMATION                                                            SEC01890
C                                                                                          SEC01900
0095                WRITE(PRNTR,9350)                                                      SEC01910
0096             9350 FORMAT(///' SUPERVISED ECHO INFORMATION....'/)                       SEC01920
0097                WRITE(PRNTR,9351)SERIAL,NOPCOL,NOFET3,NOFLD                            SEC01930
0098             9351 FORMAT(5X,'CLASSIFICATION STUDY.....',I9,                            SEC01940
                   1       /5X,'NO.OF POOLS.....',I4,                                      SEC01950
                   2       /5X,'NO.OF CHANNELS.....',I4,                                   SEC01960
                   3       /5X,'NO. OF TRAINING FIELDS.....',I4)                           SEC01970
C                                                                                          SEC01980
C  REDUCE STATISTICS                                                                       SEC01990
C                                                                                          SEC02000
0099                CALL REDSAV(ARRAY(COVAR1),ARRAY(AVAR1),ARRAY(COVAR3),ARRAY(AVAR3),SEC02010
                   1 KEPPTS,NOPOOL,NOFET,VARSTZ,NOFET3,POLPTR,POLSTK,FETVEC,FETVC3,    SEC02020
                   2 VARSZ3)                                                               SEC02030
C                                                                                          SEC02040
C  WRITE OUT INITIAL RECORDS                                                               SEC02050
C                                                                                          SEC02060
0100                IF (CHKOUT) RETURN                                                     SEC02070
0101                DO 390 I=1,NOPOOL                                                      SEC02080
0102              390 WORK(I) = 0.0                                                        SEC02090
0103                II = 3                                                                 SEC02100
0104                JJ = 0                                                                 SEC02110
0105                KK = 1                                                                 SEC02120
0106                I = INTTAP                                                             SEC02130
0107                J = INTFIL                                                             SEC02140
0108                PREFIX(1) = 1                                                          SEC02150
0109                PREFIX(2) = 0                                                          SEC02160
0110                IF (PHASE2) I = RQTAPE                                                 SEC02170
0111                IF (PHASE2) J = RQFILE                                                 SEC02180
0112                WRITE (OUTPUT) PREFIX,I,J,II,JJ,SERIAL,KK,(JJ,IJ=1,6)                  SEC02190
0113                PREFIX(1) = 2                                                          SEC02200
0114                IF (.NOT. PHASE2) IWORK(1) = CELWTH                                    SEC02210
0115                IF (.NOT. PHASE2) WORK(2) = THRES                                      SEC02220
0116                WRITE (OUTPUT) PREFIX,NOCLS,NCFET3,NOFLD,NCPCOL,                       SEC02230
                   1 (FETVC3(I),I=1,NOFET3),(CSEL3(FETVC3(I)),I=1,NOFET3),              SEC02240
                   2(FRQCAL(1,FETVC3(I)),I=1,NOFET3),(FRQCAL(2,FETVC3(I)),I=1,NOFET3)   SEC02250
                   3,((POLNAM(I,J),I=1,2),J=1,NOPOOL),((POLPTR(I,J),I=1,2),J=1,NOPOOL)SEC02260
                   4,(POLSTK(I),I=1,NOCLS),(WORK(I),I=1,NCPOOL),DATE                       SEC02270
C                                                                                          SEC02280
```

FILE SECINT

```
0117                REWIND SDATA                                                SEC02290
0118                PREFIX(1) = 3                                               SEC02300
0119             400 READ(SCATA,9390,END=9100) CARD                             SEC02310
0120            9390 FORMAT(20A4)                                               SEC02320
0121                WRITE (OUTPUT) PREFIX,CARD                                  SEC02330
0122                IF (CARD(1) .EQ. IEOS) GO TO 410                            SEC02340
0123                GO TO 400                                                   SEC02350
                C                                                               SEC02360
                CC PRINT STATS, CALC INVERSE COVAR MTX,SCAPRD, VECTOR PRD, DET  SEC02370
                C                                                               SEC02380
0124             410 CALL SECPRT(ARRAY(COVAR3),ARRAY(AVAR3),ARRAY(SCRAR3),ARRAY(DETAR3)SEC02390
                   1,ARRAY(CONAR3),ARRAY(DATBS3))                               SEC02400
0125             420 IF (.NOT. PHASE1) GO TO 458                                SEC02410
                C*****************************************************************SEC02420
                C                                                               SEC02430
                CC PHASE1 ONLY                                                  SEC02440
                C                                                               SEC02450
                C*****************************************************************SEC02460
0126                REWIND CLASSX                                               SEC02470
0127                PREFIX(2) = 0                                               SEC02480
                C                                                               SEC02490
                CC ENTER LOOP TO READ AND CLASSIFY THE REGIONS.                 SEC02500
                C                                                               SEC02510
0128             425 READ (CLASSX, END = 530) INFO                              SEC02520
0129             426 PREFIX(2) = PREFIX(2)+1                                    SEC02530
                C                                                               SEC02540
                CC GET RUN NUMBER                                               SEC02550
                C                                                               SEC02560
0130                IF(CURRUN.EQ.INFO(1))GO TO 460                              SEC02570
0131                CALL GETRUN(INFO(1),DATAPE,ID,ERROR,RUNTAB,IMARK)           SEC02580
0132                IF(ERROR.GT.0) CALL RUNERR(ERROR,INFO(1))                   SEC02590
0133             430 DO 440 I = 1,NOFET3                                        SEC02600
0134                IF(FETVC3(I).LE.ID(5))GO TO 440                             SEC02610
0135                WRITE(PRNTR,9430)FETVC3(I)                                  SEC02620
0136                WRITE(TYPEWR,9430)FETVC3(I)                                 SEC02630
0137            9430 FORMAT (10X,' CHANNEL ',I3)                                SEC02640
0138                CALL ERPRNT (178,'STOP')                                    SEC02650
0139             440 CONTINUE                                                   SEC02660
                C                                                               SEC02670
                CC SET UP CALIBRATION SET VECTOR.                               SEC02680
                C                                                               SEC02690
0140                DO 450 J = 1,30                                             SEC02700
0141                DO 450 I = 1,3                                              SEC02710
0142             450 IF(CSET3(I,J) .EQ. -50000.) CSET3(I,J) = FRQCAL(I+2,J)     SEC02720
                C                                                               SEC02730
                CC CHECK FOR NEW CALIBRATION                                    SEC02740
                C                                                               SEC02750
0143                FLAG = 0                                                    SEC02760
0144                DO 455 I = 1,NOFET3                                         SEC02770
0145                DO 455 J = 1,3                                              SEC02780
0146             455 IF(ABS(CSET(J,FETVC3(I))-CSET3(J,FETVC3(I))) .GT. 1.02) FLAG = 1  SEC02790
0147                IF(FLAG.EQ.1) WRITE(TYPEWR,9455)                            SEC02800
0148                IF(FLAG.EQ.1) WRITE(PRNTR,9455)                             SEC02810
0149            9455 FORMAT(' IO214 CALIBRATION VALUES USED FOR CLASSIFICATION ARE NOT  SEC02820
                   1SAME AS THOSE USED IN THE STATISTICS')                      SEC02830
0150                GO TO 460                                                   SEC02840
                C                                                               SEC02850
                C*****************************************************************SEC02860
                C                                                               SEC02870
                CC PHASE 2 ONLY - CHECK ALL SUCESSIVE AREAS ON TAPE             SEC02880
                C                                                               SEC02890
                C*****************************************************************SEC02900
                C                                                               SEC02910
0151             458 READ(INPUT) PREFIX,PTS,LINES,INFO,ID,CSET3                 SEC02920
0152                IF (PTS .EQ. 0) GO TO 426                                   SEC02930
                C                                                               SEC02940
                CC          COMPUTE FIELD SIZE AND SET UP STORAGE ALLOCATION.   SEC02950
                C                                                               SEC02960
0153             460 LSAMNO = ID(6) - 6                                         SEC02970
0154                IF (INFO(8) .LE. LSAMNO) GO TO 470                          SEC02980
0155                WRITE (TYPEWR,9460) INFO(8), LSAMNO                         SEC02990
0156            9460 FORMAT (' IO212 LAST SAMPLE NUMBER (',I4,') EXCEEDS LAST SAMPLE ONSEC03000
                   1 TAPE.  LAST SAMPLE NUMBER RESET TO',I5,'.')                SEC03010
0157                WRITE (PRNTR,9460) INFO(8), LSAMNO                          SEC03020
0158               - INFO(8) = LSAMNO                                           SEC03030
                C                                                               SEC03040
```

```
FILE SECINT
C SET UP JPTS AS NO OF CELLS HORIZONTALLY,PTS AS NUMBER OF TRUNCATED PTS
C
      470 JPTS = (INFO(8)-INFO(7)+INFO(9))/(INFO(9)*CELWTH)
          PTS = JPTS * CELWTH
C
C RESET INFO (8) TO CORRESPOND TO TRUNCATION
C
          INFO(8) = INFO(7) + (PTS-1)*INFO(9)
          J = INFO(6) * CELWTH
          INFO(5) = INFO(4) + J*((INFO(5)-INFO(4)+INFO(6))/J) - INFO(6)
          NSR = PTS+6
          CELSIZ = CELWTH*CELWTH
C
C NVR IS NUM OF SAMPLES IN ADATA TO SKIP TO GET NEXT CHAN OF DATA
C  FOR THIS POINT
C
          NVR = NSR*NOFET3
          NWORD = MAXO(NOPOOL,(CELSIZ+1)/2)
          NWORD2 = NWORD*2
C
C ALLOCATE ARRAYS USED IN ACTUAL CELL SPLITTING BY ECH03
C
C ARRAYS ARE ------     BDATA FOR READING IN DATA
C                       PIXCLS FOR CLASS OF GIVEN PIXEL FROM NON-HOMOGEN
C                              CELL
C                       CELIKE FOR STORING LIKELIHOOD CODE FOR EACH CELL
C                      RDATA FOR READING IN DATA
C                      PIXCOR FOR CORRELATION (DATA VALUE PRODUCTS) OF PIX
C                      PIXVAL FOR ACTUAL PIXEL DATA VALUES
C                      CELCOR FOR CELL CORRELATION MATRIX VALUES
C                      CELSUM FOR SUM OF ALL DATA VALUES IN CELL
C                      CELCLS FOR CLASS NO OF CELL
C                      DATBS3 FOR REST OF STUFF
C*****************************************************************
          CELSUM = DATBS3
          VARSZ3 = NOFET3*(NOFET3+1)/2
          IF (.NOT. PHASE1) GO TO 480
          BDATA = DATBS3
          RDATA = BDATA + (NOFET3*ID(6) + 7)/8
          PIXCOR = RDATA + (NVR*CELWTH+1)/2
          PIXVAL = PIXCOR + (VARSZ3*CELSIZ+1)/2
          CELCOR = PIXVAL + (NOFET3*CELSIZ+1)/2
          CELSUM = CELCOR + (VARSZ3+1)/2
      480 CELCLS = CELSUM + (NOFET3+1)/2
          CELIKE = CELCLS + (JPTS+3)/4
          PIXCLS = CELIKE + (NWORD*JPTS+1)/2
          PRTBUF = CELIKE + (PTS+3)/4
          DATBS3 = PRTBUF + (PTS+3)/4
C
C PHASE 2 ALLOCATION
C
          IF (.NOT. PHASE2) GO TO 490
          STACK = DATBS3
          CLOSED = STACK + (JPTS+1)/2
          OPEN = CLOSED + (JPTS + 3)/4
          FLDSIZ = OPEN + (JPTS+3)/4
          FLOCLS = FLDSIZ + (JPTS+1)/2
          FLOLIK = FLOCLS + (JPTS+3)/4
          DATBS3 = FLOLIK + (JPTS * NOPOOL+1)/2
C
C
      490 IF (DATBS3 .GT. TOP) CALL ERPRNT(139,'STOP')
          BUFROZ = 50000/(JPTS*2*CELSIZ)
          IF (BUFROZ .LE. 1) CALL ERPRNT(139,'STOP')
C
C PRINT OUT PROCESSING PARAMETERS
C
          WRITE(PRNTR,9500) CELWTH,NOFET3,NOPOOL,THRES, GSELEC, BUFROZ
 9500 FORMAT(1////10PROCESSING PARAMETERS'//
     1 '  CELL WIDTH = ',I2//
     2 '  NUMBER OF CHANNELS = ',I3//
     3 '  NUMBER OF POOLED CLASSES = ',I3//
     4 '  ANNEXATION THRESHOLD = ',1P E12.4//
```

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

FILE SECINT

```
                4,'  CELL SELECTION THRESHOLD = ',1P E12.4//                          SEC03810
                5'  NUMBER OF CELL LINES IN BUFFER = ',I7)                          SEC03820
              C                                                                     SEC03830
              C PRINT RUN HEADER                                                    SEC03840
              C                                                                     SEC03850
0196                CALL GETIME(TIME)                                               SEC03860
0197                WRITE(PRNTR,HEAD)                                               SEC03870
0198                CALL HEADER(NOFET3,FETVC3,CSEL3,CSET3,ID,FRQCAL)                SEC03880
              C*********************************************************************SEC03890
              C                                                                     SEC03900
              C WRITE RECORD TYPE 5.                                                SEC03910
              C                                                                     SEC03920
              C*********************************************************************SEC03930
              C                                                                     SEC03940
0199            520 LINES = (INFO(5)-INFO(4))/INFO(6) + 1                           SEC03950
              C                                                                     SEC03960
              C CORRECT AREA INFO PUT ON INTERMEDIATE TAPE TO REFLECT CELL LINES    SEC03970
              C                                                                     SEC03980
02C0            527 PREFIX(1) = 5                                                   SEC03990
0201                WRITE (OUTPUT) PREFIX,PTS,LINES,INFO,ID,CSET3                   SEC04000
0202                PREFIX(1) = 6                                                   SEC04010
              C                                                                     SEC04020
              C PRINT HEADER.                                                       SEC04030
              C                                                                     SEC04040
0203                WRITE(PRNTR,9520) (INFO(I),I=4,9)                               SEC04050
0204             9520 FORMAT('0AREA PROCESSED...LINES ',I6,'-',I5,'  (BY ',I2,')'/  SEC04060
                    & T21,'COLUMNS ',I4,'-',I5,'  (BY ',I2,')'/)                    SEC04070
              C                                                                     SEC04080
              C*********************************************************************SEC04090
              C                                                                     SEC04100
              C CLASSIFY THE REGION.                                                SEC04110
              C                                                                     SEC04120
              C*********************************************************************SEC04130
              C                                                                     SEC04140
0205                CALL SECH01(ARRAY(COVAR3),ARRAY(AVAR3),ARRAY(SCRAR3),           SEC04150
                    & ARRAY(DETAR3),ARRAY(CONAR3),                                  SEC04160
                    & ARRAY(BDATA),  ARRAY(RDATA),  ARRAY(PIXCOR), ARRAY(PIXVAL),   SEC04170
                    & ARRAY(CELCOR), ARRAY(CELSUM), ARRAY(CELIKE), ARRAY(CELCLS),   SEC04180
                    & ARRAY(PIXCLS), ARRAY(STACK), ARRAY(OPEN), ARRAY(CLOSED),      SEC04190
                    & ARRAY(FLDSIZ), ARRAY(FLDCLS), ARRAY(FLDLIK), ARRAY(PRTBUF),   SEC04200
                    & BUFFER(1))                                                    SEC04210
0206                IF (.NOT.PHASE1.AND.PHASE2) GO TO 458                           SEC04220
0207                GO TO 425                                                       SEC04230
              C                                                                     SEC04240
              C END OF FILE RECORD                                                  SEC04250
              C                                                                     SEC04260
0208            530 PTS = 0                                                         SEC04270
0209                PREFIX(1) = 8                                                   SEC04280
0210                PREFIX(2) = 0                                                   SEC04290
0211                WRITE (OUTPUT,ERR= 536) PREFIX, PTS, LINES, INFO, ID, CSET3     SEC04300
0212                WRITE(PRNTR,9535)                                               SEC04310
0213             9535 FORMAT('0ECF RECORD WRITTEN.')                                SEC04320
0214                GO TO 537                                                       SEC04330
0215             536 WRITE(PRNTR,9536)                                              SEC04340
0216             9536 FORMAT('0ERROR WHILE WRITING EOF RECORD.')                    SEC04350
0217             537 IF(OUTPUT .EQ. CLASSR) RETURN                                  SEC04360
              C                                                                     SEC04370
              C*********************************************************************SEC04380
              C                                                                     SEC04390
              C FINISH TAPE                                                         SEC04400
              C                                                                     SEC04410
              C*********************************************************************SEC04420
              C                                                                     SEC04430
0218                CALL TOPEF (OUTPUT)                                             SEC04440
0219            540 CALL TOPRF (OUTPUT)                                             SEC04450
0220                IO = 0                                                          SEC04460
0221                I3 = 3                                                          SEC04470
0222                K = -1                                                          SEC04480
0223                FILESV = FILESV+1                                               SEC04490
0224                PREFIX(1) = 1                                                   SEC04500
0225                PREFIX(2) = 0                                                   SEC04510
0226                WRITE (OUTPUT) PREFIX, RQTAPE, FILESV, I3, K, (IO,I=1,8)        SEC04520
0227                CALL TOPEF (OUTPUT)                                             SEC04530
0228                CALL TOPRF (OUTPUT)                                             SEC04540
0229                CALL TOPEF (OUTPUT)                                             SEC04550
0230                CALL TOPBF (OUTPUT)                                             SEC04560
```

FILE SECINT

```
0231            CALL TOPBF (OUTPUT)                                                 SEC04570
0232       8900 RETURN                                                              SEC04580
0233       9000 WRITE(TYPEWR,99000)                                                 SEC04590
0234            WRITE (PRNTR,99000)                                                 SEC04600
0235      99000 FORMAT(' E***  END OF RECORD READING INTERMEDIATE TAPE -')          SEC04610
0236            GO TO 9900                                                          SEC04620
0237       9100 WRITE(TYPEWR,99100)                                                 SEC04630
0238            WRITE (PRNTR,99100)                                                 SEC04640
0239      99100 FORMAT(' E***  UNEXPECTED END OF FILE READING STATS FROM DISK -')   SEC04650
0240       9900 WRITE (TYPEWR,99900)                                                SEC04660
0241            WRITE (PRNTR,99900)                                                 SEC04670
0242      99900 FORMAT('       FUNCTION TERMINATED   (SUPINT)')                    SEC04680
0243            CALL RTMAIN                                                         SEC04690
0244            END                                                                 SEC04700
```

LARS Program Abstract _____

MODULE IDENTIFICATION

Module Name: MTAPE Function Name: ECHO FUNCTIONAL SUPPORT

Purpose: Mounts and positions results or intermediate tapes

System/Language: CMS/FORTRAN

Author: P. D. Alenduff Date: 4/8/77

Latest Revisor: _____ Date: _____

MODULE ABSTRACT

MTAPE mounts and positions the results or intermediate tape (or a tape to be used as output for copying results files).

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1. Module Usage

MTAPE

CALL MTAPE (RQTAPE, RQFILE, MODE)

Input Arguments:

RQTAPE	I*4 Tape number of requested tape. A tape number of 0 is a request for a scratch tape.
RQFILE	I*4 File number of requested file. If RQFILE is = 0, then the tape will be initialized by writing a record type 1 on the results tape with file-type = 0.
MODE	I*4 Flag indicating usage of MMTAPE. MODE = -1 indicates MMTAPE has been called to mount and position a tape to be used for copying results files onto. Mode = 0 indicates that a results tape is being mounted for reading a results file. In this case, the tape is mounted ring out. Also, if MODE = 0, RQFILE = 0 is invalid and will cause an error when an attempt is made to write on the tape. MODE = 1 indicates a tape is being mounted for writing a new results file (or continuing a suspended classification). MODE = 2 indicates a tape is to be used as an intermediate tape for reading an intermediate results file. The difference

between MODE = -1 and MODE = +1 is the DSRN used for the tape. For MODE = -1 and -2 DSRN is CPYOUT and for MODE = +1, DSRN is MAPTAP. (DSRN is MAPTAP for MODE = 0).

Output Arguments:

RQTAPE	I*4 When MODE = 0, set to -1 if requested tape file was full and user decided to use disk for results. Otherwise, remains unchanged.
RQFILE	I*4 When MODE = 1, set to -1 if requested tape file was full and user decided to use disk for results. Otherwise, sends back current file position of tape.

MTAPE checks the validity of the tape by reading the record type 1 from the tape and verifying the tape and file number as well as checking fro the correct type of file. Any attempt to overwirte an existing file causes MTAPE to ask the user (via the typewriter) if he wishes to overwrite the file, respecify a new results card, or terminate the function. Note, however, that if a request has been made to initialize a tape, no checking is performed on previous contents.

2. Internal Description

See output description.

3. Input Description

The record type 1 of the results tape is read for each

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file up to and including the file needed. That is, if file 4 is requested the record type 1 is read from files 1-4.

4. Output Description

The following information messages are issued under the circumstances listed. The term filetype means the file-type code from record type 1 of a results file (the program uses variable CHECK for this number).

I0041 is typed when a tape has been mounted and before MTAPE positions it. This message is not typed when the tape is being initialized or when the correct type number was already mounted.

I0043 is typed when MODE = ±1 and file type of the requested file = 0.

I0044 is typed when MODE = ±1 and filetype of the requested file = 1 and the restart flag from GLOCOM (RESTRT) is not = 1.

I0045 is typed when the tape is correctly positioned. This is not typed when initializing a tape.

After I0043 and I0044, the user is asked whether he wishes to overwrite the file, respecify a new results card with a new tape and/or file or disk option, or terminate the function.

I0100 is typed to allow entry of the new results card. This occurs when the user requests to respecify the results card.

I0101 is typed to confirm usage of disk for results and occurs whenever disk is specified on the results card.

The following error messages are typed under the conditions listed.

E361 is written when the tape is being filed forward and a file is encountered with filetype other than zero before the requested file is reached and MODE = 0.

E362 is written when the circumstances for E361 occurs and MODE = 1. It is also written when MODE = 1 and the filetype of the file requested is = -1.

E363 is written if the RESTRT flag is = 1 and the filetype of the requested file is not = 1.

E364 is written when MODE = 1 and the filetype of the file requested = 1.

E365 is written when an EOF is read on the results file. This should never occur with valid results files.

For message texts refer to the User's Manual.

5. Supplemental Information

This section deals with the handling of tapes by MMTAPE.

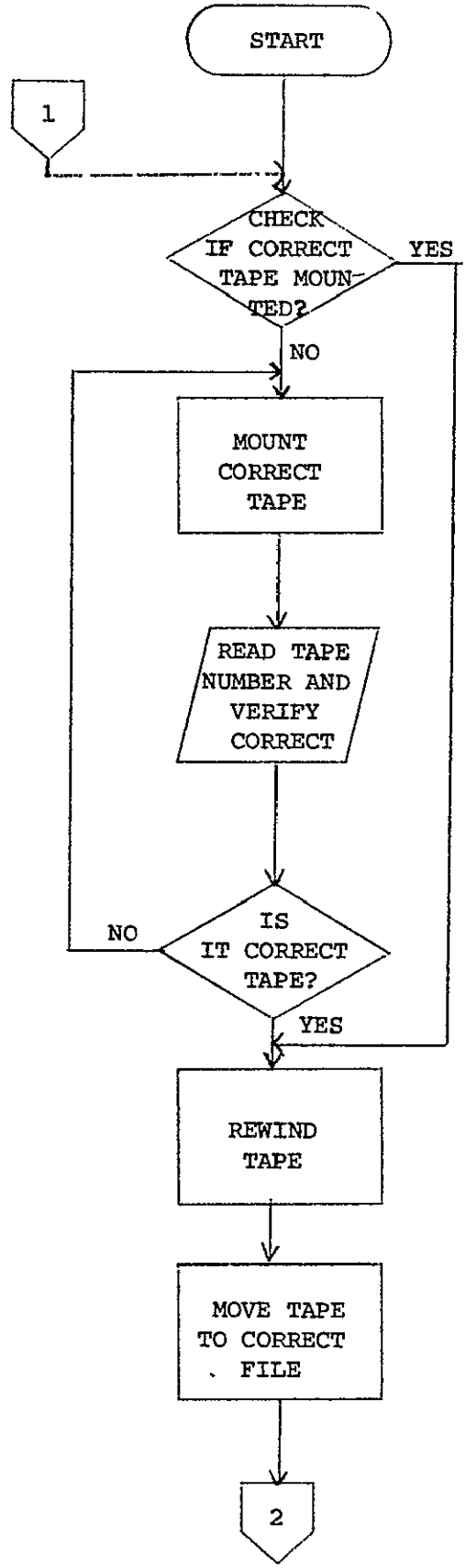
Input:

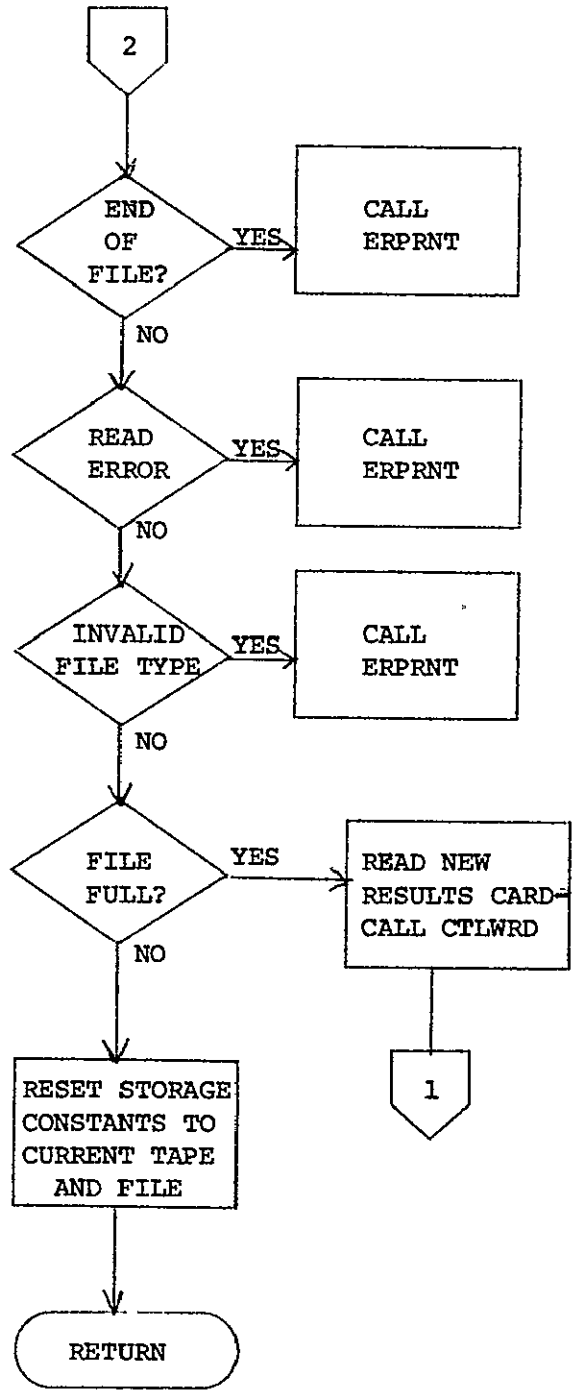
If a tape is mounted on the device and it is the incorrect tape number (as noted from the appropriate status words in GLOCOM), TOPRU is called to unload the tape before the correct tape is mounted. If the correct tape is mounted, MTAPE will check for the ring in if MODE = $\pm$1. If the ring is not in, the tape is unloaded and MOUNT is called to mount the tape with the ring in. If the correct tape is mounted, MTAPE assumes that the file number (as recorded in GLOCOM) is correct and moves the tape backwards or forwards to find the requested file.

Output:

The tape is mounted with ring in for MODE = $\pm$1 and with ring out for MODE = 0 and -2.

The tape is left positioned at the beginning of the requested file. When the tape is initialized a TOPRW is used to do this.


START
1
CHECK IF CORRECT TAPE MOUN-TED?
YES
NO
MOUNT CORRECT TAPE
READ TAPE NUMBER AND VERIFY CORRECT
IS IT CORRECT TAPE?
NO
YES
REWIND TAPE
MOVE TAPE TO CORRECT FILE
2


2
END OF FILE?
YES
CALL ERPRNT
NO
READ ERROR
YES
CALL ERPRNT
NO
INVALID FILE TYPE
YES
CALL ERPRNT
NO
FILE FULL?
YES
READ NEW RESULTS CARD
CALL CTLWRD
1
NO
RESET STORAGE CONSTANTS TO CURRENT TAPE AND FILE
RETURN

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```
FORTRAN IV G LEVEL  20.7              MTAPE            DATE = 77129        15025011          PAGE 0001
FILE MTAPE
                C        MTAPE    LARS  0000                                                    MMT00010
                C                                                                               MMT00020
                C*******************************************************************          MMT00030
                C                                                                               MMT00040
                C MTAPE      MOUNTS AND POSITIONS RESULTS TAPES                                 MMTC0050
                C                                                                               MMT00060
                C*******************************************************************          MMT00070
                C                                                                               MMT00080
0001                 SUBROUTINE MTAPE (RQTAPE,RQFILE,MODE)                                      MMTCC090
                C                                                                               MMT00100
0002                 IMPLICIT INTEGER * 4 (A-Z)                                                 MMT00110
0003                 COMMON /GLECOM/ BLANK, CARD(20), CHKOUT, COPFIL, CLASSR, CLASSX,           MMT00120
                    1    CLUSTR, COMPUT, CPYOUT, ERORDR, CRDSEQ, DATAPE,                       MMT00130
                    2    DUPLTP, DUPRUN, ERRMSG, FBPNT,                                        MMT00140
                    3    FILESV, FLDBND, HDATA, HEAD(88), ID(200), IMAGEX,                     MMT00150
                    4    IMARK, KEYBD, MAPTAP, MAXCHA, MAXCLS,                                 MMT00160
                    5    PAGSIZ, PACH, POINT, PRESUX, PNTR, READIN,                            MMT00170
                    6    RESTRT, RUNFIL, RUNTAB(10,3),                                         MMT00180
                    7    SDATA, SEPARX, SEPTPX, SPARE(10), TEMPAS(30),                         MMT00190
                    8    TPSTAT(6), TYELDX ,TYPEWR,                                            MMT00200
                    9    TOP, ARRAY(12500)                                                     MMT00210
                C                                                                               MMT00220
0004                 REAL * 8 ARRAY                                                             MMT00230
0005                 REAL * 4 FROCAL(5,30)                                                      MMT00240
0006                 INTEGER * 4 COMENT(16), DATE(5), HED1(16), HED2(16), TIME(5)               MMT00250
0007                 INTEGER * 2 BLANK2                                                         MMT00260
0008                 LOGICAL * 4 CHKOUT                                                         MMT00270
0009                 LOGICAL * 1 BLANK1                                                         MMT00280
0010                 EQUIVALENCE (DATSAV,ID(1)), (CURRUN,ID(3)), (FROCAL(1),ID(5)),            MMT00290
                    1        (HED(1),READ(8)), (DATE(1),HEAD(26)), (HED2(1),HEAD(39)),MMTCC300
                    2        (TIME(1),HEAD(58)), (COMENT(1),HEAD(72)),                         MMT00310
                    3        (MAPSAV,TPSTAT(1)),                                               MMTCC320
                    4        (SEPSCR,TPSTAT(2)), (DUPIN,TPSTAT(3)), (DASTAT,TPSTAT(4)),MMT00330
                    5        (COPSER,TPSTAT(5)), (TRAOLT,TPSTAT(6)),                           MMT00340
                    6        (BLANK,BLANK2,BLANK1)                                             MMT00350
                C                                                                               MMT00360
                C                                                                               MMT00370
0011                 INTEGER * 4 PREFIX(2), RESCOD(3), CLACOD(4)                                MMT00380
0012                 DATA PREFIX/0,1/, RESULT/'RESU'/, RESCOD/'CVER','RESP','TERM'/,            MMTCC390
                    1    CLACOD/'TAPE','FILE','INIT','DISK'/                                   MMT00400
                C                                                                               MMT00410
                C*******************************************************************          MMT00420
                C                                                                               MMT00430
                C ANS    = REPLY FROM USER AS TO WHETHER TO CONTINUE WITH RUN                   MMT00440
                C CHECK  = FLAG NOTING TYPE OF FILE ON RESULTS TAPE                             MMT00450
                C          0 = RESULTS FILE, -1 = CHECK RECORD (WRITTEN AFTER LAST              MMT00460
                C          RESULTS OF RESTART FILE ON TAPE), 1 = RESTART FILE                   MMTC0470
                C ERRGR  = ERROR CODE FROM CPFUNC (NOT USED)                                    MMT00480
                C I1     = CONSTANT USED WRITING INITIAL RECORD ONTO TAPE                       MMT00490
                C I3     = CONSTANT USED WRITING INITIAL RECORD ONTO TAPE                       MMTC0500
                C K      = USED AS DUMMY READING VERSION NUMBER FROM TAPE                       MMTC0510
                C MODE   = INDICATES FUNCTION OF MMTAPE, SUPPLIED FROM CALLER                   MMT00520
                C          = 1 MEANS WISH TO GET TAPE READY FOR WRITING CLASSIFICATION          MMT00530
                C          RESULTS, = 0 MEANS WISH TO GET TAPE READY FOR PRINTING               MMTC0540
                C          RESULTS, = -1 MEANS MOUNT TAPE FOR COPYING CLASSIFICATION            MMT00550
                C          RESULTS ONTO.                                                        MMT00560
                C RQFILE = REQUESTED FILE NUMBER IN TAPE TO BE READIED. IF RQFILE               MMT00570
                C          IS INPUT AS A 0, THEN MMTAPE IS TO WRITE AN INITIAL                  MMT00580
                C          RECORD ONTO THE TAPE.                                                MMTC0590
0013                 CONTINUE                                                                   MMT00600
                C RQTAPE = REQUESTED TAPE NUMBER TO BE MOUNTED. A ZERO MEANS SCRATCH TAPMMT00610
                C          OK. IF BOTH RQTAPE AND RQFILE = -1, TAPE HAD RESULTS AND DISK MMT00620
                C          WILL BE USED FOR RESULTS.                                            MMT00630
                C IFO    = FILE NUMBER AS READ FROM RESULTS TAPE                                MMT00640
                C INO    = TAPE NUMBER AS READ FROM RESULTS TAPE                                MMTC0650
                C UNI1   = DSKN OF TAPE BEING MOUNTED                                          MMT00660
                C          THIS WILL BE MAPTAP UNLESS MOUNTING COPYRESULTS OUTPUT TAP          MMT00670
                C                                                                               MMT00680
0014                 1 CONTINUE                                                                 MMT00690
                C*******************************************************************          MMT00700
                C                                                                               MMT00710
0015                 INITFG = 0                                                                 MMT00720
                C                                                                               MMT00730
                C IF USER REJECTS TAPE/FILE PREVIOUSLY REQUESTED, DISK WILL BE USED            MMT00740
                C                                                                               MMT00750
0016                 100 IF (RQTAPE .EQ  -1 .AND. RQFILE .EQ. -1) RETURN                        MMT00760
```

```
FORTRAN IV G LEVEL  20 7              MTAPE G          DATE = 77129        15025011          PAGE 0002
FILE MTAPE
0017                 UNIT = MAPTAP                                                              MMT00770
0018                 IF (MODE .LE. -1) GO TO 108                                                MMT00780
0019                 FILNO = FILESV                                                             MMT00790
                C                                                                               MMT00800
                C        IF CORRECT TAPE IS MOUNTED GO TO POSITIONING                           MMT00810
                C                                                                               MMT00820
0020                 IF (MAPSAV  EQ. RQTAPE) GO TO 130                                          MMT00830
0021               105 IF (MAPSAV  NE. -1) CALL TOPRW(MAPTAP)                                   MMT00840
0022                 GO TO 110                                                                  MMT00850
0023               108 UNIT = CPYOUT                                                            MMT00860
0024                 FILNO = COPFIL                                                             MMT00870
0025                 IF (COPSER .NE. -1) CALL TOPRW(CPYOUT)                                     MMT00880
0026               110 IF (MODE .EQ. 1) CALL MOUNT (RQTAPE,MAPTAP,'RI')                         MMT00890
0027                 IF (MODE .EQ. 0) CALL MOUNT (RQTAPE,MAPTAP,'RO')                          MMT00900
0028                 IF (MODE .EQ. -1) CALL MOUNT (RQTAPE,CPYOUT,'RI')                         MMT00910
0029                 IF (MODE .EQ. -2) CALL MOUNT (RQTAPE,CPYOUT,'RO')                         MMT00920
                C                                                                               MMT00930
                C        IF CALLED FROM COPYRESULTS, THE UNIT IS COPYOUT                        MMT00940
                C                                                                               MMT00950
0030                 FILNO = 1                                                                  MMT00960
                C                                                                               MMT00970
                C        RQFILE OF 0 MEANS THE CALL IS TO INITIALIZE THE TAPE                   MMT00980
                C                                                                               MMT00990
0031                 IF (RQFILE .NE. 0) GO TO 120                                               MMT01000
0032                 I1 = 1                                                                     MMT0101C
0033                 I3 = 3                                                                     MMT01020
0034                 WRITE (UNIT) PREFIX, RQTAPE, I1, I3,(RQFILE,I=1,9)                         MMT01030
0035                 CALL TOPRW(UNIT)                                                           MMT0104C
0036                 GO TO 390                                                                  MMT01050
0037               120 WRITE (TYPEWR,9120) RQTAPE, RQFILE                                       MMT01060
0038              9120 FORMAT (' I0042  POSITIONING RESULTS TAPE',I5,' TO FILE',               MMT0107C
                    1    I4,'    (MTAPE1')                                                     MMT01080
0039                 CALL TOPRW(UNIT)                                                           MMT01090
                C                                                                               MMT01100
                C        READ FIRST RECORD AND SEE IF CORRECT TAPE IS MOUNTED                   MMT01110
                C                                                                               MMT0112C
0040                 READ (UNIT,ERR=530,END = 500) PREFIX, INO, IFO, K, CHECK                   MMT0113C
0041                 CALL TCPRW(UNIT)                                                           MMT01140
0042                 IF (INO .EQ. RQTAPE) GO TO 130                                             MMT01150
0043                 CALL CPFUNC (15,'M CP WRONG TAPE',ERROR)                                   MMT0116C
0044                 CALL TOPRU(UNIT)                                                           MMT01170
0045                 GO TO 110                                                                  MMT01180
                C                                                                               MMT01190
                C        POSITION RESULTS TAPE TO CORRECT FILE                                  MMT01200
                C                                                                               MMT01210
0046               130 IF (RQFILE .GT. 1) GO TO 140                                             MMT0122C
                C                                                                               MMT01230
                C        IF NEED RINGIN, MAKE SURE IT IS. (TAPE MAY HAVE MOUNTED                MMT0124C
                C        BY PREVIOUS PRINTRESULTS WHICH HAD RING OUT)                           MMT0125C
                C                                                                               MMT01260
0047                 IF (MODE .EQ. 0 .OR. MODE .EQ  -2) GO TO 135                               MMT0127C
0048                 CALL RINGIN (UNIT,I)                                                       MMT01280
0049                 IF (I  EQ. 0) GO TO 135                                                    MMT0129C
0050                 CALL TCPRU(UNIT)                                                           MMT01300
0051                 GO TO 110                                                                  MMT01310
0052               135 FILNO = 1                                                                MMT01320
0053                 CALL TCPRW(UNIT)                                                           MMT0133C
0054                 GO TO 200                                                                  MMT01340
0055               140 J = RQFILE - FILNO                                                       MMT01350
                C                                                                               MMT01360
                C        J IS THE NUMBER OF FILES THE TAPE MUST BE MOVED                        MMT01370
                C                                                                               MMT0138C
0056                 IF (J) 150, 200, 170                                                       MMT01390
0057               150 J = -J                                                                   MMT0140C
                C                                                                               MMT01410
                C        THE DO 160 LOOP BACKS THE TAPE UP TO THE CORRECT FILE                  MMT0142C
                C                                                                               MMT01430
0058                 DO 160 I = 1,J                                                             MMT0144C
0059                 FILNO = FILNO -1                                                           MMT01450
0060               160 CALL TOPBF(UNIT)                                                         MMT01460
0061                 GO TO 200                                                                  MMT01470
                C                                                                               MMT01480
                C        THE DO 180 LOOP FORWARD FILES THE TAPE AND CHECKS                      MMT01490
                C        TO BE SURE THAT FILES ARE REALLY THERE TO SPACE OVER                   MMT0150C
                C                                                                               MMT0151C
0062               170 DO 180 I = 1, J                                                          MMTG1520
```

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 FORTRAN IV G LEVEL  20.7              MTAPE C           DATE = 77129        15025011            PAGE 0003
FILE MTAPE
   0063              READ (UNIT,ERR=530,END=500) PREFIX, FNO, TFO, K, CHECK                      MMT01530
   0064              IF (ICHECK .NE. 0) GO TO 210                                                MMT01540
   0065              FILNO = FILNO + 1                                                           MMT01550
   0066            180 CALL TCPFF(UNIT)                                                          MMT01560
                   C                                                                             MMT01570
                   CCC     IF FILNO AND RQFILE ARE UNEQUAL , THE PROGRAM HAS GOODFED.            MMT01580
                   C                                                                             MMT01590
   0067            200 IF (FILNO .NE. RQFILE) CALL ERPRNT (100,'STOP')                           MMT01600
                   C                                                                             MMT01610
                   CCC     NOW READ THE FIRST RECORD OF THE FILE AND CHECK VALIDITY               MMT01620
                   C                                                                             MMT01630
   0068              READ (UNIT,ERR=530,END=500)  PREFIX, FNO, TFO, K, CHECK                     MMT01640
                   CCC                                                                           MMT01650
                   CCC     CHECK FOR ERROR OF RESTART OPTION BUT NOT RESTART FILE                MMT01660
                   CCC                                                                           MMT01670
   0069              IF (RESTRT .EQ. 1 .AND. CHECK .NE. 1) CALL ERPRNT (363,'STOP')              MMT01680
   0070              IF (MODE .NE. 0.AND MODE .NE. -2) GO TO 225                                 MMT01690
   0071              IF (ICHECK .NE. -1) GO TO 220                                               MMT01700
   0072              I = FILNO - 1                                                               MMT01710
                   C                                                                             MMT01720
                   CCC     THE FOLLOWING CODE PROCESSES ERROR FOR INVALID FILE TYPE              MMT01730
                   C                                                                             MMT01740
   0073            210 CALL ERPRNT (361+IABS(MODE),'GO')                                         MMT01750
   0074                WRITE (PANTR,9210) I                                                      MMT01760
   0075                WRITE (TYPEWR,9210) I                                                     MMT01770
   0076             9210 FORMAT (I10,' FILE',I3)                                                 MMT01780
   0077                CALL RTMAIN                                                               MMT01790
                   C                                                                             MMT01800
                   CCC     IF A RESTART FILE,  AND RESTART NOT SPECIFIED, ERROR                  MMT01810
                   C                                                                             MMT01820
   0078            220 IF (ICHECK  EQ  1) CALL ERPRNT (364,'STOP')                               MMT01830
   0079                GO TO 300                                                                 MMT01840
   0080            225 IF (ICHECK  EQ  -1 .AND. RESTRT .EQ  0) GO TO 300                         MMT01850
   0081                IF (RESTRT .NE  1) GO TO 230                                              MMT01860
   0082                IF (CHECK .EQ  1) GO TO 300                                               MMT01870
                   C                                                                             MMT01880
                   CCC     ERROR OF RESTARTING AND NO RESTART FILE                               MMT01890
                   C                                                                             MMT01900
   0083                CALL ERPRNT (260,'STOP')                                                  MMT01910
   0084            230 IF (ICHECK .NE  0) GO TO 233                                              MMT01920
   0085                WRITE (TYPEWR, 9230)                                                      MMT01930
   0086                WRITE (PRNTR, 9230)                                                       MMT01940
   0087             9230 FORMAT (' I0043  FILE HAS RESULTS IN IT - DO YOU WISH TO ',             MMT01950
                       1       'OVERWRITE THE FILE, RESPECIFY THE ENTIRE RESULTS CARD,',/       MMT01960
                       2       ' OR TERMINATE THE JOB (OVERWRITE, RESPECIFY, TERMINATE) ',     MMT01970
                       3       '     (MTAPE)')                                                  MMT01980
   0088            233 IF (ICHECK .NE  1) GO TO 235                                              MMT01990
   0089                WRITE (TYPEWR, 9235)                                                      MMT02000
   0090                WRITE (PRNTR, 9235)                                                       MMT02010
   0091             9235 FORMAT (' I0044  FILE IS A RESTART FILE - DO YOU WISH TO ',             MMT02020
                       1       'OVERWRITE THE FILE, RESPECIFY THE ENTIRE RESULTS CARD,',/       MMT02030
                       2       ' OR TERMINATE THE JOB (OVERWRITE, RESPECIFY, TERMINATE) ',     MMT02040
                       3       '     (MTAPE)')                                                  MMT02050
   0092            235 COL = C                                                                   MMT02060
   0093                ERRCOR = 3                                                                MMT02070
   0094                CALL C1LWRD (CARD, COL, RESCOD, 3, CODE, KEYBD, ERRCOR)                   MMT02080
   0095                IF (ERRCOR .EQ  4) CALL RTMAIN                                            MMT02090
   0096                GO TO (300,240,241), CODE                                                 MMT02100
   0097            240 WRITE(TYPEWR,9250)                                                        MMT02110
   0098                WRITE (KEYBD, 9250)                                                       MMT02120
   0099             9250 FORMAT (' I0100  ENTER RESULTS CARD       (MMTAPE)')                   MMT02130
   0100                COL = C                                                                   MMT02140
   0101                ERRCOR = 3                                                                MMT02150
   0102            242 CALL C1LWRC (CARD, COL, RESULT, 1, CODE, KEYBD, ERRCOR)                   MMT02160
   0103                IF (ERRCOR .EQ. 4) CALL RTMAIN                                            MMT02170
   0104            241 IF (COL .EQ  72) GO TO 100                                                MMT02180
   0105                CALL C1PRM (CARD, COL, CLACOD, 4, CODE, &245)                             MMT02190
   0106                GO TO (250,260,270,280),CODE                                              MMT02200
                   C                                                                             MMT02210
                   CC TERMINATE OPTION                                                           MMT02220
                   C                                                                             MMT02230
   0107            244 CALL RTMAIN                                                               MMT02240
                   CC                                                                            MMT02250
                   CC RETYPE RESULTS CARD AFTER ERROR IN ENTRY                                   MMT02260
                   C                                                                             MMT02270
   0108            245 ERRCOR = 1                                                                MMT02280
```

```
 FORTRAN IV G LEVEL  20.7              MTAPE C           DATE = 77129        15025011            PAGE 0004
FILE MTAPE
   0109                GO TO 242                                                                 MMT02290
                   C                                                                             MMT02300
                   C PROCESS PARAMETER ERRORS                                                    MMT02310
                   C                                                                             MMT02320
   0110            248 WRITE (TYPEWR, 9248) CARD                                                 MMT02330
   0111             9248 FORMAT (5X,20A4)                                                        MMT02340
   0112                CALL ERPRNT (ERRNUM, 'GO')                                                MMT02350
   0113                GO TO 242                                                                 MMT02360
                   C                                                                             MMT02370
                   C DECODE TAPE SPECIFICATION                                                   MMT02380
                   C                                                                             MMT02390
   0114            250 VECSZ = 1                                                                 MMT02400
   0115                CALL IVAL (CARD, COL, RQTAPE, VECSZ, &252)                                MMT02410
   0116                IF (VECSZ .EQ. 0) GO TO 252                                               MMT02420
   0117                GO TO 243                                                                 MMT02430
   0118            252 ERRNUM = 348                                                              MMT02440
   0119                GO TO 248                                                                 MMT02450
                   C                                                                             MMT02460
                   C FILE SPECIFICATION                                                          MMT02470
                   C                                                                             MMT02480
   0120            260 VECSZ = 1                                                                 MMT02490
   0121                CALL IVAL (CARD, COL, RQFILE, VECSZ, &252)                                MMT02500
   0122                IF (VECSZ  EQ  0) GO TO 252                                               MMT02510
   0123                GO TO 243                                                                 MMT02520
   0124            265 ERRNUM = 347                                                              MMT02530
   0125                COL = C                                                                   MMT02540
   0126                ERRCOR = 3                                                                MMT02550
   0127                GO TO 242                                                                 MMT02560
                   C                                                                             MMT02570
                   C INITIALIZE SPECIFICATION                                                    MMT02580
                   C                                                                             MMT02590
   0128            270 INITFG = 1                                                                MMT02600
   0129                GO TO 243                                                                 MMT02610
                   C                                                                             MMT02620
                   C DISK SPECIFICATION -- WHEN DISK APPEARS ON CARD, IT OVERRIDES OTHER         MMT02630
                   C       PARAMETERS. CANNOT CHECK FOR WHEN BOTH SPECIFIED ON CARD SINCE        MMT02640
                   C       RQTAPE AND RQFILE ARE ALREADY USED (IN MOUNTED TAPE)                  MMT02650
                   C                                                                             MMT02660
   0130            280 RQTAPE = -1                                                               MMT02670
   0131                RQFILE = -1                                                               MMT02680
   0132                WRITE (TYPEWR, 9280)                                                      MMT02690
   0133             9280 FORMAT (' I0101  DISK WILL BE USED FOR RESULTS      (MMTAPE)')       MMT02700
   0134                GO TO 100                                                                 MMT02710
   0135             300 WRITE (TYPEWR,9300)                                                      MMT02720
   0136             9300 FORMAT (' I0045  RESULTS TAPE MOUNTED AND POSITIONED',                  MMT02730
                       1       '     (MMTAPE)')                                                MMT02740
   0137                CALL TCPFF(UNIT)                                                          MMT02750
   0138            390 IF (MODE .LE. -1) GO TO 400                                               MMT02760
   0139                PAPSAV = RQTAPE                                                           MMT02770
   0140                FILESV = FILNO                                                            MMT02780
   0141                RETURN                                                                    MMT02790
   0142            400 COPSER = RQTAPE                                                           MMT02800
   0143                COPFIL = FILNO                                                            MMT02810
   0144                RETURN                                                                    MMT02820
   0145            500 CALL ERPRNT (365,'STOP')                                                  MMT02830
   0146            510 REWIND KEYBD                                                              MMT02840
   0147                GO TO 280                                                                 MMT02850
   0148            530 CALL ERPRNT (261,'STOP')                                                  MMT02860
   0149                END                                                                       MMT02870
```

LARS Program Abstract _____

MODULE IDENTIFICATION

Module Name: SECHO1 Function Name: SECSUP

Purpose: Performs Supervised ECHO Processing on area.

System/Language:

Author: P. D. Alenduff Date: 4/11/77

Latest Revisor: Date:

MODULE ABSTRACT

This routine is called once for each area to be classified and performs all classification on each line of data and produces the output file.

PURDUE UNIVERSITY
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1. Module Usage

SECHO1

```
CALL SECHO1 (ICLSCV, VECPRD, SCAPRD, DETCOV, CONST, BDATA,
             RDATA, PIXCOR, PIXVAL, CELCOR, CELSUM, CELIKE,
             CELCLS, PIXCLS, STACK, OPEN, CLOSED, FLDSIZ,
             FLDLIK, PRTBUF, BUFFER)
```

Input Arguments:

ICLSCV (VARSZ3, NOPOOL)	R*4 An array dimensioned (channels * (channels + 1)/2) * number of classes, containing the upper half of the triangular covariance matrices for each of the classes used for classification.
VECPRD (NOFET3, NOPOOL)	R*4 An array dimensioned channels * classes containing the vector product of the classes for each channel from the inverse covariance matrix and the determinant of the covariance matrix.
SCAPRD (NOPOOL)	R*4 An array dimensioned "classes" for the scalar product of the mean and covariance matrices for each class.
DETCOV (NOPOOL)	R*4 An array dimensioned "classes" words for the determinant of the covariance matrix for each class.
CONST (NOPOOL)	R*4 An array dimensioned "classes" words containing the constant term used consisting of an expression with

	determinant and scalar product for each class.
BDATA ((NOFET3*ID(6))/2)	I*2 The array used for reading the byte information of data values from data tape.
RDATA (NVR, CELWTH)	R*4 The array dimensioned "(ID(6)-6) * cell width" words for reading actual data values from tape and calibrating them.
PIXCOR (VARSZ3 * CELSIZ)	R*4 The array dimensioned (channels * (channels + 1)/2) by (cell width)^2 words for storing the cross product terms of the data values of a cell (correlation term).
PIXVAL (NOFET3 *CELSIZ)	R*4 An array dimensioned "channels * (cell width)^2" for storing actual pixel data values for each channel for 1 cell.
CELCOR (VARSZ3)	R*4 An array dimensioned (channels * (channels + 1))/2 words for saving the cross product of the pixel values.
CELSUM (NOFET3)	R*4 An array dimensioned "channels" words used to store the sum of data values for each pixel in the cell for a given channel number.
CELIKE (NWORD, JPTS)	R*4 An array dimensioned "NWORD by columns of cells" for storing the cell likelihoods or pixel values for each

	cell in the line.
CELCLS (JPTS)	I*2 An array dimensioned "column" of cells halfwords used to contain the most likely class number of all cells in a given row.
PIXCLS (NWORD, JPTS)	I*2 The array dimensioned NWORD2 by "column" halfwords for storing the class number of each pixel in a given cell for singular cells (equivalent to CELIKE).
STACK (JPTS)	I*2 A stack of field numbers for the cell in the given position for a row of cells.
OPEN (JPTS)	L*1 An array of "column" bytes used as logical flags to store whether or not a particular column of cells has been opened as a field.
CLOSED (JPTS)	L*1 An array of logical values for each column of cells to indicate whether the field for each column has been opened for annexation.
FLDSIZ (JPTS)	I*4 The array of "column" halfwords to store the length of the current field.
FLDCLS (JPTS)	I*2 The array of "column" halfwords to store the length of the current fields as the number of previously annexed rows in this column.

FLDLIK (NOPOOL, JPTS)	R*4 The array of likelihoods dimensioned columns of cells by classes words used to store the likelihood of each field for each class.
PRTBUF (JPTS)	I*2 The output print buffer dimensioned "columns of cells" halfwords.
BUFFER (BUFROZ * JPTS)	I*2 The buffer array used for annexation of neighboring rows of cells dimensioned BUFROZ * JPTS.

SECH01 performs processing of an area to be classified. If only an intermediate tape is to be produced, cell information is gathered and written to tape. Otherwise all information is used in annexation and classification, and the classification results are written to the output device. Any maps are also produced.

2. Internal Description

Initially, column headers are printed if any map is to be produced. All buffer pointers and cell arrays are initialized so that the arrays OPEN and CLOSE indicate that no annexation and classification has taken place. Then a loop is entered and executed once for each row of cells (two or more data lines). The routine FILBUF is called to gather statistics on one row of cells, either directly from processing the data tape, or from reading the intermediate tape. If no annexation is to be performed, the information is written to the output device and this loop is executed until this entire area is completed and a return

is executed. Otherwise, a series of calls to LIKRAT for a comparison of the likelihood of the cell being annexed to the cell above, left, and right is performed. The cell is annexed to the most likely cell if the comparison with the annexation threshold is successful. This is continued for all cells in the row. When finished, any fields formed from adjoining cells that are closed and no longer continued are classified and then any new fields are opened in that statistics from the initial cell are copied into the array storing field statistics. Then LIKRAT is called to classify closed areas. A print buffer is then filled with symbols for either the cell map or classification amp and printed out. Statistics are handled for remaining open fields and the row is written to the output tape. This is continued until the area has been processed.

3. Input Description

Not applicable

4. Output Description

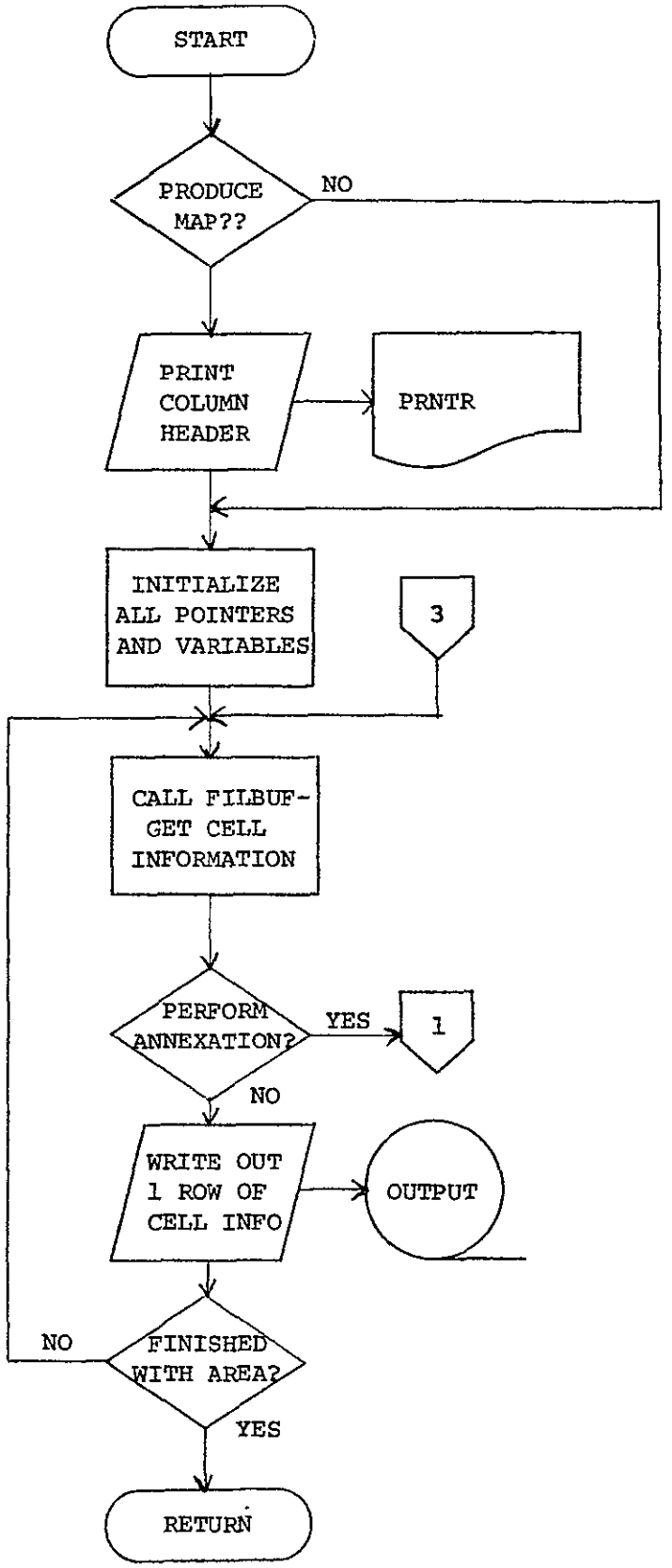
The unit PRNTR receives the map and column header produced if a map is to be printed.

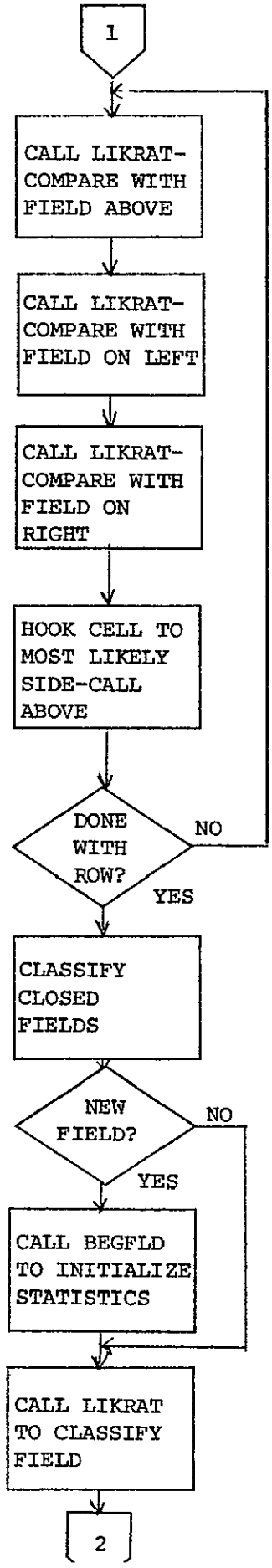
The unit OUTPUT is used as the output unit for either intermediate tape - cell information or classified cell lines. These lines follow the format of regular classification records.

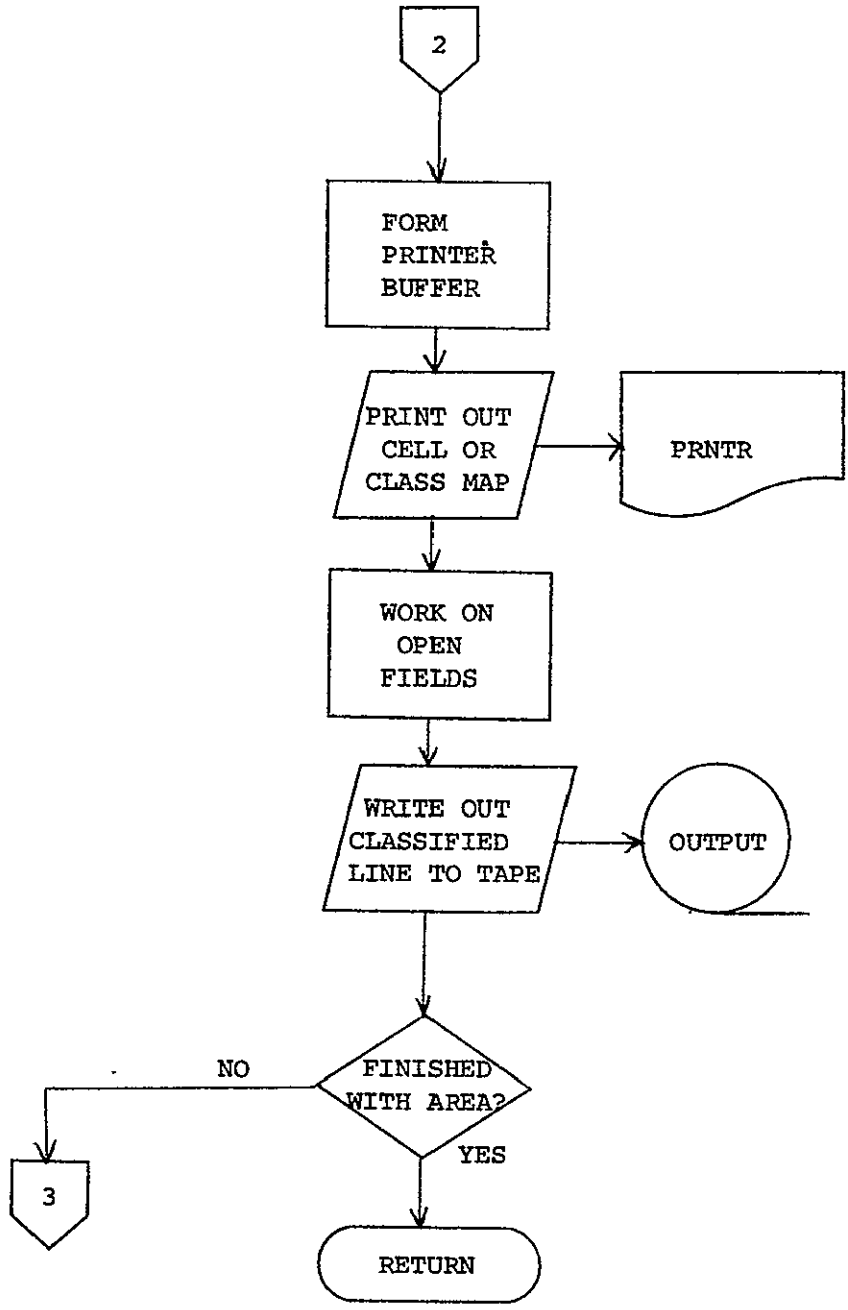
5. Supplemental Information

This program uses common blocks GLOCOM and SECCOM.

6. FLOWCHART


START
PRODUCE MAP??
NO
PRINT COLUMN HEADER
PRNTR
INITIALIZE ALL POINTERS AND VARIABLES
3
CALL FILBUF- GET CELL INFORMATION
PERFORM ANNEXATION?
YES
1
NO
WRITE OUT 1 ROW OF CELL INFO
OUTPUT
NO
FINISHED WITH AREA?
YES
RETURN


1
CALL LIKRAT-COMPARE WITH FIELD ABOVE
CALL LIKRAT-COMPARE WITH FIELD ON LEFT
CALL LIKRAT-COMPARE WITH FIELD ON RIGHT
HOOK CELL TO MOST LIKELY SIDE-CALL ABOVE
DONE WITH ROW?
NO
YES
CLASSIFY CLOSED FIELDS
NEW FIELD?
NO
YES
CALL BEGFLD TO INITIALIZE STATISTICS
CALL LIKRAT TO CLASSIFY FIELD
2


2
FORM PRINTER BUFFER
PRINT OUT CELL OR CLASS MAP
PRNTR
WORK ON OPEN FIELDS
WRITE OUT CLASSIFIED LINE TO TAPE
OUTPUT
FINISHED WITH AREA?
NO
YES
3
RETURN

REPRODUCIBILITY OF THE
ORIGINAL PAGE IS POOR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 FORTRAN IV G LEVEL  20.7              SECHO1            DATE = 77129        15021059              PAGE 0001
FILE SECHO1
                C      SECHO1      LARS  XXXX                                                      ECH00010
                C                                                                                 ECH00020
                C SPECIAL VERSION TO IMPLEMENT EXTRA SCANNING LOGIC.                              ECH00030
                C*****************************************************************************ECH00040
                C                                                                                 ECH00050
 0001                 SUBROUTINE SECHO1(ICLSCV,VECPRD,SCAPRD,DETCOV,CONST,                       ECH00060
                1 SDATA,NDATA,PIXCOR,PIXVAL,CELCOR,CELSUM,                                        ECH00070
                2 CELIKE,CELCLS,PIXCLS,STACK,OPEN,CLOSED,FLDSIZ,FLOCLS,                           ECH00080
                3 FLDLIK,PRIBUF,BUFFER)                                                           ECH00090
 0002                 IMPLICIT INTEGER * 4 (A-Z)                                                 ECH00100
                C                                                                                 ECH00110
 0003                 COMMON /GLCCOM/ BLANK, CARD(20), CHKOUT, COPEFL, CLASSR, CLASSX,           ECH00120
                1     CLUSTX, CONPUT, CRYOUT, CRDADR, CROSEC, DATAPE,                             ECH00130
                2     DUPFLP, DUPRUN, ERRMSG, FSPNT,                                              ECH00140
                3     FILESV, FLOBND, HDATA, HEAD(88), ID(200), IMAGEX,                           ECH00150
                4     IMARK, KEYBD, MAPTAP, MAXCHA, MAXCLS,                                       ECH00160
                5     MACSIZ, PNCH, POINT, PRESUV, PNNTR, READIN,                                 ECH00170
                6     RESTRT, RUNFIL, RUNTAB(10,3),                                               ECH00180
                7     SDATA, SEPARX, SEPTPX, SPARE(10), TEMPAS(30),                               ECH00190
                8     TPSTAT(6), TTELDX ,TYPEWR,                                                  ECH00200
                9     TOP, ARRAY(12500)                                                           ECH00210
                C                                                                                 ECH00220
 0004                 REAL * 8 ARRAY                                                             ECH00230
 0005                 REAL * 4 FROCALL(5,30)                                                     ECH00240
 0006                 INTEGER * 4 COMENT(16), DATE(5), HED1(16), HED2(16), TIME(5)               ECH00250
 0007                 INTEGER * 2 BLANK2                                                         ECH00260
 0008                 LOGICAL * 4 CHKOUT                                                         ECH00270
 0009                 LOGICAL * 1 BLANK1                                                         ECH00280
 0010                 EQUIVALENCE (DATSAV,ID(1)), (CURRUN,ID(3)), (FROCAL(1),ID(5)),             ECH00290
                1           (HED1(1),HEAD(1)), (DATE(1),HEAD(26)), (HED2(1),HEAD(39)),ECH00300
                2           (TIME(1),HEAD(58)), (COMENT(1),HEAD(72)),                          ECH00310
                3           (MAPSAV,TPSTAT(1)),                                                ECH00320
                4           (SEPSCR,TPSTAT(2)), (DUPIN,TPSTAT(3)), (DASTAT,TPSTAT(4)),ECH00330
                5           (ECPSER,TPSTAT(5)), (TRADUT,TPSTAT(6)),                            ECH00340
                6           (BLANK,BLANK2,BLANK1)                                              ECH00350
                C                                                                                 ECH00360
                C                                                                                 ECH00370
 0011                 COMMON /SECCOM/ BUFADZ,CSELEC,CSET1(3,30),CSET3(3,30),THRES,CELSIZ,ECH00380
                1 CELWTH,INFO(17),INPUT, INTTAP, INTFIL, JPTS, LINES, NOCLS, NOFET,ECH00390
                2 NOFET3,NOPOOL,NWORD,NWORD2, NVR, OUTPUT, POLNAM(2,60), PREFIX(2),ECH00400
                3 PTS, ROTAPE, SCFILE, SYMCNT, VARSZ3, CSEL(30), CSEL3(30),        ECH00410
                4 FETVEC(30),FETVC3(30), POLPTR(2,60), POLSTK(60),                 ECH00420
                5 CDFLAG, CLSMAP, CSET1(3,30), OBJMAP, PHASE1, PHASE2, POLNM1(60), ECH00430
                6 PRSTAT, SYM(60), SYMXTX(60)                                      ECH00440
                C                                                                                 ECH00450
 0012                 REAL * 4 CSELEC, CSET, CSET3, THRES, ANN1                                  ECH00460
                C                                                                                 ECH00470
 0013                 INTEGER * 2 CSEL, CSEL3, FETVEC, FETVC3, POLPTR, POLSTK                    ECH00480
                C                                                                                 ECH00490
 0014                 LOGICAL * 1 CDFLAG, CLSMAP, CSET1, OBJMAP, PHASE1, PHASE2, POLNM1,ECH00500
                1 PRSTAT                                                                          ECH00510
                C                                                                                 ECH00520
                CCC                                                                               ECH00530
                C                                                                                 ECH00540
                C*****************************************************************************ECH00550
                C                                                                                 ECH00560
                C DEFINE LOCAL VARIABLES                                                          ECH00570
                C                                                                                 ECH00580
                C*****************************************************************************ECH00590
 0015                 REAL * 4 BCATA(NVR,CELWTH),CELIKE(NWORD,JPTS),FLDLIK(NOPOOL,JPTS),ECH00600
                1 ICLSCV(VARSZ3,NOPOOL),VECPRD(NOFET),NOFECT),SCAPRD(NOPOOL),      ECH00610
                2DETCOV(NOPOOL),CONST(NOPOOL),CELSUM(NOFET3),CELCOR(VARSZ3),       ECH00620
                3 PIXVAL(1),PIXCOR(1),AUXCLK(60,4),SUP,SRIGHT,SLEFT,SUPLUS,ANN1    ECH00630
                C                                                                                 ECH00640
 0016                 INTEGER * 4 FLDSIZ(JPTS)                                                   ECH00650
                C                                                                                 ECH00660
 0017                 INTEGER * 2 CELCLS(JPTS),PIXCLS(NWORD2,JPTS),BCATA(1),STACK(JPTS),ECH00670
                1 BUFFER(1), FLDCLS(JPTS), PRTBUF(JPTS),BLOCK(4), M2, CLASSZ,       ECH00680
                2 JPTS2, SINGUL, VERTI, HORIZ, PLUS, L2, BLANK2, AUXCLS(4),KSYM(1)  ECH00690
                C                                                                                 ECH00700
 0018                 LOGICAL * 1 OPEN(JPTS),CLOSED(JPTS),STOP                                   ECH00710
                C                                                                                 ECH00720
 0019                 EQUIVALENCE (FSTLIN,INFO(4)), (LSTLIN,INFO(5)), (LININT,INFO(6))   ECH00730
 0020                 EQUIVALENCE (CURLIN,INFO(4)),(SYM(1),KSYM(1))                              ECH00740
 0021                 DATA SINGUL,VERTI,HORIZ,PLUS,L2/'0','I','-','/','L'/                       ECH00750
                C                                                                                 ECH00760
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 FORTRAN IV G LEVEL  20.7              SECHO1            DATE = 77129        15021059              PAGE 0002
FILE SECHO1
 0022                 ASSIGN 220 TO ALPHA                                                        ECH00770
 0023                 ROWSIZ = JPTS * CELSIZ                                                     ECH00780
                C                                                                                 ECH00790
                C TURN OFF COLUMN HEADER IF NO PHASE2 PROCESSING                                  ECH00800
                C                                                                                 ECH00810
 0024                 IF (.NOT. PHASE2) GO TO 90                                                 ECH00820
                C                                                                                 ECH00830
                C TRANSFORM ANNEXATION PARAMETER                                                  ECH00840
                C                                                                                 ECH00850
 0025                 ANN1 = -ALOG(10.-)*THRES                                                   ECH00860
                C                                                                                 ECH00870
                CC                                                                                ECH00880
                C PRINT COLUMN NUMBERS ON OUTPUTV                                                 ECH00890
                C                                                                                 ECH00900
 0026                 N = INFO(9)*CELWTH                                                         ECH00910
 0027                 IF ( NOT. CLSMAP  AND. .NOT. OBJMAP) GO TO 90                              ECH00920
 0028                 L = INFO(7)                                                                ECH00930
 0029                 INTVL = (JPTS + 110) / 111                                                 ECH00940
 0030                 JPTS1 = JPTS / INTVL                                                       ECH00950
 0031                 M = L + (JPTS1-1)*N                                                        ECH00960
 0032                 II = 1                                                                     ECH00970
 0033                 IF(M .GT  999) II=10                                                       ECH00980
 0034                 I = L                                                                      ECH00990
 0035                 DO 30 K=1,JPTS1                                                            ECH01000
 0036                 PRTBUF(K) = I/(100*II)                                                     ECH01010
 0037                 PRTBUF(K+JPTS1) = MOD(I,100*II)/(10*II)                                    ECH01020
 0038                 PRTBUF(K+2*JPTS1) = MOD(I,10*II)/II                                        ECH01030
 0039              30 I = I+N                                                                    ECH01040
 0040                 II = 2*JPTS1+1                                                             ECH01050
 0041                 DO 40 I=1,II,JPTS1                                                         ECH01060
 0042                 J = I+JPTS1-1                                                              ECH01070
 0043              40 WRITE(PRNTR,9040) (PRTBUF(K),K=I,J)                                        ECH01080
 0044            9040 FORMAT(' ',3X,111I1)                                                       ECH01090
 0045                 IF(M .LE. 999) GO TO 50                                                    ECH01100
 0046                 I = L                                                                      ECH01110
 0047                 DO 45 J=1,JPTS1                                                            ECH01120
 0048                 PRTBUF(J) = MOD(I,10)                                                      ECH01130
 0049              45 I = I+N                                                                    ECH01140
 0050                 WRITE(PRNTR,9040) (PRTBUF(I),I=1,JPTS1)                                    ECH01150
 0051              50 WRITE(PRNTR,9120)                                                          ECH01160
 0052            9120 FORMAT('0')                                                                ECH01170
                C                                                                                 ECH01180
                C*****************************************************************************ECH01190
                CC                                                                                ECH01200
                C INITIALIZE                                                                      ECH01210
                C                                                                                 ECH01220
                C*****************************************************************************ECH01230
 0053                 90 JPTS2 = JPTS                                                            ECH01240
                C                                                                                 ECH01250
                C SKIP ZEROING OUT ARRAYS IF ONLY PHASE1 (THEY'RE NOT ALLOCATED---)               ECH01260
                C                                                                                 ECH01270
 0054              100 IF ( NOT  PHASE2) GO TO 105                                               ECH01280
 0055                 DO 110 I = 1,JPTS                                                          ECH01290
 0056                 STACK(I) = I                                                               ECH01300
 0057                 CLOSED(I) = .TRUE.                                                         ECH01310
 0058              110 OPEN(I) = .FALSE.                                                         ECH01320
 0059              105 GLCR = LININT*CELWTH                                                      ECH01330
 0060                 CELSZ1 = CELSIZ - 1                                                        ECH01340
 0061                 NOLINE = 0                                                                 ECH01350
 0062                 PLINE = FSTLIN                                                             ECH01360
 0063                 NEXT = 1                                                                   ECH01370
 0064                 PRTRW = 1                                                                  ECH01380
 0065                 OLDRW = 0                                                                  ECH01390
 0066                 NEWRW = 1                                                                  ECH01400
 0067                 CURLIN = FSTLIN                                                            ECH01410
                C                                                                                 ECH01420
                C*****************************************************************************ECH01430
                CC                                                                                ECH01440
                C ENTER MAIN LOOP                                                                 ECH01450
                C                                                                                 ECH01460
                C*****************************************************************************ECH01470
                C                                                                                 ECH01480
 0068              150 J = NOLINE*CELWTH                                                         ECH01490
 0069                 IF(MOD(NOLINE,50) .EQ. 0) WRITE(TYPEWR,9150) J                             ECH01500
 0070            9150 FORMAT(16,' LINES CLASSIFIED.')                                           ECH01510
 0071                 NOLINE = NOLINE + 1                                                        ECH01520
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 FORTRAN IV G LEVEL  20.7              SECHO1G           DATE = 77129        15021059          , PAGE 0003
FILE SECHO1
0072                 OROWBS = 1 + (OLDRW-1)*ROWSIZ                                          ECHO1530
0073                 NROWBS = 1 + (NEWRW-1)*ROWSIZ                                          ECHO1540
C                                                                                           ECHO1550
C    ( ( ( END ROW OF DATA                                                                  ECHO1560
C                                                                                           ECHO1570
0074                 CALL FILBUF(ILLSCV,WECPRD,SCAPND,LEFCOV,CLNS1,BDATA,RDATA,             ECHO1580
     1 PIXCOR,PIXVAL,CELCOR,CELSUM,CELIKE,CELCLS,PIXCLS,CURLIN)                             ECHO1590
0075               155 IF ( NOT  CBJMAP) GO TO 157                                          ECHO1600
0076                   IJJ = 1                                                              ECHO1610
0077                   DO 156 I=1,JPTS,INTVL                                                ECHO1620
0078                   PRTBUF(IJJ) = BLANK2                                                 ECHO1630
0079                   IF (CELCLS(I) .NE. 0) GO TO 156                                      ECHO1640
0080                   PRTBUF(IJJ) = SINGUL                                                 ECHO1650
0081               156 IJJ = IJJ + 1                                                        ECHO1660
0082                   L = CURLIN                                                           ECHO1670
0083                   WRITE(IPRNTR,92901)L,(PRTBUF(I),I=1,JPTS1)                           ECHO1680
0084               157 IF (PHASE2) GO TO 160                                                ECHO1690
0085                   WRITE(CUTPUT) PREFIX,CURLIN,CELCLS,CELIKE                            ECHO1700
0086                   CURLIN = CURLIN + GLCB                                               ECHO1710
0087                   IF (CURLIN  GE. INFONS)) RETURN                                      ECHO1720
0088                   GO TO 150                                                            ECHO1730
C                                                                                           ECHO1740
C    INSERT IN BUFFER CLASS NUMBERS FOR EACH PIXEL OF SINGULAR CELLS                        ECHO1750
C                                                                                           ECHO1760
0089               160 J = NROWBS                                                           ECHO1770
0090                   DO 200 CELNUM=1,JPTS                                                 ECHO1780
0091                   BUFFER(J) = 0                                                        ECHO1790
0092                   IF(CELCLS(CELNUM) .NE. 0) GO TO 200                                  ECHO1800
0093                   K = J                                                                ECHO1810
0094                   DO 165 I=1,CELSIZ                                                    ECHO1820
0095                   BUFFER(K) = PIXCLS(I,CELNUM) + JPTS2                                 ECHO1830
0096               165 K = K + 1                                                            ECHO1840
0097               200 J = J + CELSIZ                                                       ECHO1850
C                                                                                           ECHO1860
C                                                                                           ECHO1870
C                                                                                           ECHO1880
C                                                                                           ECHO1890
C                                                                                           ECHO1900
C                                                                                           ECHO1910
0098                99200 FORMAT(1X,2814)                                                   ECHO1920
0099                   IF(OLDRW .EQ. 0) GO TO 265                                           ECHO1930
C                                                                                           ECHO1940
C    COMPARE CELLS WITH FIELDS.                                                             ECHO1950
C    COMPARE CURRENT ROW WITH PREVIOUS ROW.                                                 ECHO1960
C                                                                                           ECHO1970
0100               228 M = 1                                                                ECHO1980
0101                   N = 1                                                                ECHO1990
0102                   I3 = OROWBS                                                          ECHO2000
0103                   J3 = NROWBS                                                          ECHO2010
C                                                                                           ECHO2020
C                                                                                           ECHO2030
C                                                                                           ECHO2040
C                                                                                           ECHO2050
C                                                                                           ECHO2060
C                                                                                           ECHO2070
0104                   DO 240 CELNUM = 1,JPTS                                               ECHO2080
0105                   I2 = I3                                                              ECHO2090
0106                   I3 = I3 + CELSIZ                                                     ECHO2100
0107                   J2 = J3                                                              ECHO2110
0108                   J3 = J3 + CELSIZ                                                     ECHO2120
0109                   FLDUP = BUFFER(I2)                                                   ECHO2130
0110                   IF(FLDUP .LE. JPTS) CLOSED(FLDUP) = .FALSE.                          ECHO2140
0111                   IF(BUFFER(J2) .EQ. 0) GO TO 229                                      ECHO2150
0112                   M = N                                                                ECHO2160
0113                   GO TO 240                                                            ECHO2170
0114               229 SUP    = -1E+70                                                     ECHO2180
0115                   SRIGHT = -1E+70                                                     ECHO2190
0116                   SLEFT  = -1E+70                                                     ECHO2200
C                                                                                           ECHO2210
C    TRY TO COMPARE CELL WITH FIELD ABOVE.                                                  ECHO2220
C                                                                                           ECHO2230
0117                   IF(FLDSIZ(FLDUP) GE MAXSIZ .OR  FLDUP.GT JPTS) GO TO 230             ECHO2240
0118                   SUP = SUPLUS                                                         ECHO2250
C                                                                                           ECHO2260
C    N .NE. M  IFF CELL 'CELNUM' HAS ALREADY BEEN COMPARED TO FIELD 'FLDUP'                 ECHO227C
C                                                                                           ECHO2280
```

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 FORTRAN IV G LEVEL  20.7              SECHO1G           DATE = 77129        15021059          PAGE 0004
FILE SECHO1
C    IN WHICH CASE SETTING M=N IS ALL THAT IS NECESSARY.                                    ECHO229C
C                                                                                           ECHO2300
0119                   IF(N .EQ  M) CALL LIKRAT(SUP,CELIKE(1,CELNUM),FLDLIK(1,FLDUP),      ECHO2310
     &                                AUXLIK(1,M),CELCLS(CELNUM),FLDCLS(FLDUP),AUXCLS(M))  ECHO2320
0120               230 M = N                                                                ECHO2330
C                                                                                           ECHO234C
C    TRY TO COMPARE CELL WITH FIELD ON LEFT.                                                ECHO2350
C                                                                                           ECHO2360
0121                   FLDLFT = 0                                                           ECHO2370
0122                   IF(CELNUM .EQ. 1) GO TO 232                                          ECHO2380
0123                   FLDLFT = BUFFER(J1)                                                  ECHO2390
0124                   IF(FLDLFT.LE.JPTS  AND. FLDLFT.GT.0 .AND  FLDLFT NE.FLDUP  AND.      ECHO2400
     &                                                FLDSIZ(FLDLFT).LT.MAXSIZ)           ECHO241C
     & CALL LIKRAT(SLEFT,CELIKE(1,CELNUM),FLDLIK(1,FLDLFT),AUXLIK(1,2),                    ECHO242C
     & CELCLS(CELNUM),FLDCLS(FLDLFT),AUXCLS(2))                                           ECHO2430
C                                                                                           ECHO2440
C    TRY TO COMPARE CELL WITH FIELD ON RIGHT.                                               ECHO2450
C                                                                                           ECHO246C
0125               232 IF(CELNUM .EQ  JPTS) GO TO 234                                       ECHO2470
0126                   FLORT = BUFFER(I3)                                                   ECHO2480
0127                   IF(FLORT.GT.JPTS .OR  FLDSIZ(FLORT) GE.MAXSIZ .OR.                   ECHO2490
     &                                                FLDLFT.EQ.FLDUP) GO TO 234          ECHO25CC
0128                   IF(BUFFER(J3).NE.0 .OR. FLORT EQ FLDLFT) GO TO 234                   ECHO2510
0129                   N = M                                                                ECHO2520
0130                   IF(M .EQ. 4) N=1                                                     ECHO2530
0131                   CALL LIKRAT(SUPLUS,CELIKE(1,CELNUM+1),FLDLIK(1,FLORT),AUXLIK(1,N),   ECHO2540
     & CELCLS(CELNUM+1),FLDCLS(FLORT),AUXCLS(N))                                          ECHO2550
0132                   IF(SUPLUS  GE.  ANN1) CALL LIKRAT(SRIGHT,CELIKE(1,CELNUM),           ECHO256C
     & AUXLIK(1,N),AUXLIK(1,3),CELCLS(CELNUP),AUXCLS(N),AUXCLS(3))                        ECHO2570
C                                                                                           ECHO2580
C    FIND GREATEST LIKELIHOOD RATIO.                                                        ECHO2590
C                                                                                           ECHO260C
0133               234 IF(SUP LT SLEFT .OR  SUP.LT.SRIGHT) GO TO 236                        ECHO2610
0134                   IF(SUP .LT. ANN1) GO TO 240                                          ECHO2620
0135                   OPEN(FLDUP) = .TRUE.                                                 ECHO2630
0136                   FIELD = FLDUP                                                        ECHO264C
0137                   K = M                                                                ECHO2650
0138                   GO TO 239                                                            ECHO2660
C                                                                                           ECHO2670
0139               236 IF(SLEFT .GE. SRIGHT) GO TO 238                                      ECHO2680
0140                   IF(SRIGHT .LT  ANN1) GO TO 240                                       ECHO2690
0141                   OPEN(FLORT) = .TRUE.                                                 ECHO2700
0142                   FIELD = FLORT                                                        ECHO2710
0143                   K = 3                                                                ECHO272C
C                                                                                           ECHO2730
C    ADD CELL TO FIELD.                                                                     ECHO2740
C                                                                                           ECHO2750
0144                   BUFFER(J3) = FLORT                                                   ECHO2760
0145                   FLOSIZ(FLORT) = FLOSIZ(FLORT) + CELSIZ                               ECHO2770
0146                   GO TO 239                                                            ECHO2780
C                                                                                           ECHO2790
0147               238 IF(SLEFT .LT  ANN1) GO TO 240                                        ECHO2800
0148                   FIELD = FLDLFT                                                       ECHO2810
0149                   K = 2                                                                ECHO2820
C                                                                                           ECHO2830
C    ADD CURRENT CELL TO FIELD                                                              ECHO2840
C                                                                                           ECHO2850
0150               239 BUFFER(J2) = FIELD                                                   ECHO2860
0151                   CALL ADD2(FLDLIK(1,FIELD),AUXLIK(1,K),FLDCLS(FIELD),AUXCLS(K),       ECHO287C
     & FLDSIZ(FIELD))                                                                     ECHO2880
0152               240 J1 = J2                                                              ECHO2890
C                                                                                           ECHO2900
C***********************************************************************                  ECHO2910
C                                                                                           ECHO292C
C    CLOSE FIELDS THAT ARE IN OLDRW BUT NOT IN NEWRW                                        ECHO2930
C                                                                                           ECHO2940
C***********************************************************************                  ECHO2950
C                                                                                           ECHO296C
0153                   DO 260 FIELD=1,JPTS                                                  ECHO2970
0154                   IF(CLOSED(FIELD) .OR. OPEN(FIELD)) GO TO 250                         ECHO2980
0155                   NEXT = NEXT - 1                                                      ECHO2990
0156                   STACK(NEXT) = FIELD                                                  ECHO3000
C                                                                                           ECHO3010
C    CLASSIFY CLOSED FIELDS                                                                 ECHO3020
C                                                                                           ECHO3030
0157                   CLASS2 = FLDCLS(FIELD) + JPTS2                                       ECHO3040
```

```
 FORTRAN IV G LEVEL  20 7              SECHO1G          DATE = 77129        15021059            PAGE 0005
FILE SECHO1
   0158           243 ROW = NEWRW - 1                                                          ECH03050
   0159               ASSIGN 250 TO RETURN                                                     ECH03060
   0160               GO TO 4000                                                               ECH03070
   0161           250 CLOSED(IFIELD) = .TRUE.                                                  ECH03080
   0162           260 OPENT(FIELD) = .FALSE.                                                   ECH03090
                  C                                                                           ECH03100
                  C BACKSCAN ACROSS ROW.  BEGIN NEW FIELDS.                                   ECH03110
                  C                                                                           ECH03120
   0163           265 K = NROWBS + ROWSIZ-CELSIZ                                              ECH03130
   0164               I = JPTS                                                                 ECH03140
   0165               DO 280 M=1,JPTS                                                          ECH03150
   0166               L = K - CELSIZ                                                           ECH03160
   0167               N = 1                                                                    ECH03170
   0168               I = I-1                                                                  ECH03180
   0169               H = BUFFER(K)                                                            ECH03190
                  C                                                                           ECH03200
                  C                                                                           ECH03210
                  C  IF H  GT. JPTS THIS CELL IS SINGULAR                                     ECH03220
                  C                                                                           ECH03230
   0170               IF(H .GT. JPTS) GO TO 280                                                ECH03240
                  C                                                                           ECH03250
                  C     PLACE CLASS OF FIELD H INTO EACH PIXEL OF FIELD H                     ECH03260
                  C                                                                           ECH03270
   0171               IF(H .NE. 0) GO TO 270                                                   ECH03280
   0172               K = STACK(NEXT)                                                          ECH03290
   0173               NEXT = NEXT + 1                                                          ECH03300
   0174               BUFFER(K) = H                                                            ECH03310
                  C                                                                           ECH03320
                  C CALL BEGFLD TO INITIALIZE STATISTICS FOR NEW FIELD                        ECH03330
                  C                                                                           ECH03340
   0175               CALL BEGFLD(CELCLS(N),FLOCLS(H),CELIK(1,N),FLOLIK(1,H),FLDSIZ(H))       ECH03350
   0176           270 IF(I.EQ.0  OR.  BUFFER(L) NE.0) GO TO 280                               ECH03360
                  C                                                                           ECH03370
                  C******** ** *   * *** *****   -MODIFIED--------- * *** ************  **  ECH03380
                  C                                                                           ECH03390
   0177               CALL LIKRAT(SRIGHT,CELIKE(1,I),FLOLIK(1,H),AUXLIK,CELCLS(I),            ECH03400
                 &  FLOCLS(H),AUXCLS)                                                         ECH03410
   0178               IF(SRIGHT .LT. ANN) GO TO 280                                            ECH03420
   0179               CALL ADD2(FLOLIK(1,H),AUXLIK,FLOCLS(H),AUXCLS,FLDSIZ(H))                 ECH03430
                  C                                                                           ECH03440
   0180           275 BUFFER(L) = H                                                           ECH03450
   0181           280 K = L                                                                   ECH03460
   0182               IF(OLDRW .EQ. 0) GO TO 340                                               ECH03470
   0183          9290 FORMAT(19,2X,111A1)                                                      ECH03480
   0184           340 CURLIN = CURLIN + CLCR                                                  ECH03490
   0185               IF(CURLIN  GT. LSIZ(IN)) GO TO 400                                       ECH03500
                  C                                                                           ECH03510
                  C POINT TO NEXT ROW IN BUFFER                                               ECH03520
                  C                                                                           ECH03530
   0186               OLDRW = NEWRW                                                            ECH03540
   0187           360 NEWRW = MOD(NEWRW,BUFROZ) + 1                                           ECH03550
   0188               IF(NEWRW .NE. PRTRW) GO TO 150                                           ECH03560
                  C                                                                           ECH03570
                  C CLASSIFY AND PRINT ONE ROW OF CELLS                                       ECH03580
                  C                                                                           ECH03590
   0189               K = 1 + (PRTRW-1)*ROWSIZ                                                 ECH03600
   0190               L = K + ROWSIZ-CELSIZ                                                    ECH03610
   0191               DO 365 I=K,L,CELSIZ                                                      ECH03620
   0192               M = BUFFER(I)                                                            ECH03630
   0193               IF(M  GT. JPTS) GO TO 365                                                ECH03640
   0194               CLASS2 = FLOCLS(M) + JPTS2                                               ECH03650
   0195           362 DO 364 J=I,L,CELSIZ                                                      ECH03660
   0196               IF(BUFFER(J) .NE. M) GO TO 364                                           ECH03670
   0197               N = J + CELSIZ                                                           ECH03680
   0198               CO 361 N = J,N                                                           ECH03690
   0199           361 BUFFER(N) = CLASS2                                                       ECH03700
   0200           364 CONTINUE                                                                ECH03710
   0201           365 CONTINUE                                                                ECH03720
   0202               ASSIGN 150 TO RETURN                                                     ECH03730
   0203               GO TO 4000                                                               ECH03740
                  C                                                                           ECH03750
                  C PRINT LAST PRINTER LINE.                                                  ECH03760
                  C                                                                           ECH03770
   0204           400 K = NROWBS                                                              ECH03780
   0205           410 L = CURLIN                                                              ECH03790
                  C                                                                           ECH03800
```

```
 FORTRAN IV G LEVEL  20 7              SECHO1G          DATE = 77129        15021059            PAGE 0006
FILE SECHO1
                  C CLASSIFY ALL OPEN FIELDS                                                  ECH03810
                  C                                                                           ECH03820
   0206               L = NROWBS + ROWSIZ-CELSIZ                                           ECH03830
   0207               DO 420 I=NROWBS,L,CELSIZ                                             ECH03840
   0208               FIELD = BUFFER(I)                                                    ECH03850
   0209               IF(FIELD .GT. JPTS) GO TO 420                                        ECH03860
   0210               CLASS2 = FLOCLS(FIELD) + JPTS2                                       ECH03870
   0211           415 ROW = NEWRW                                                          ECH03880
   0212               ASSIGN 420 TO RETURN                                                 ECH03890
   0213               GO TO 3000                                                           ECH03900
   0214           420 CONTINUE                                                             ECH03910
                  C                                                                       ECH03920
                  C FINISH PRINTING BUFFER.                                               ECH03930
                  C                                                                       ECH03940
   0215               ASSIGN 430 TO RETURN                                                 ECH03950
   0216           430 IF(PRTRW .EQ. NEWRW) ASSIGN 500 TO RETURN                            ECH03960
   0217               GO TO 4000                                                           ECH03970
   0218           500 PLINE = 0                                                            ECH03980
   0219               PREFIX(1) = 7                                                        ECH03990
   0220               WRITE(OUTPUT,ERR=600) PREFIX,PLINE,PRTBUF                            ECH04000
   0221               RETURN                                                               ECH04010
                  C                                                                       ECH04020
                  C*******************************************************************    ECH04030
                  C                                                                       ECH04040
                  C END OF TAPE OR IO ERROR                                               ECH04050
                  C                                                                       ECH04060
                  C*******************************************************************    ECH04070
                  C                                                                       ECH04080
   0222           600 WRITE(PRNTR,9610) PLINE                                             ECH04090
   0223          9610 FORMAT(1' [CO47 END OF TAPE OR AN I/O ERROR OCCURED. ',             ECH04100
                 &  'CLASSIFICATION TERMINATED AT LINE',I6,'.     (ECHOA53)')            ECH04110
   0224               WRITE (ITYPEW,9610) PLINE                                           ECH04120
   0225               IF(OUTPUT .EQ. CLASSR) GO TO 500                                    ECH04130
   0226               CALL TCPBS(OUTPUT,1,ERROR)                                          ECH04140
   0227               I = 1                                                               ECH04150
   0228               CALL TCPBS(OUTPUT,I,ERROR)                                          ECH04160
   0229               IF(I .LE. 0) RETURN                                                 ECH04170
   0230               BACKSPACE OUTPUT                                                    ECH04180
   0231               GO TO 500                                                           ECH04190
                  C                                                                       ECH04200
                  C PROPAGATE CLASSIFICATION THROUGHOUT BUFFER.                           ECH04210
                  C                                                                       ECH04220
   0232          3000 IF(ROW .LE. 0) ROW=BUFROZ                                           ECH04230
   0233               STOP = .TRUE                                                        ECH04240
                  C                                                                       ECH04250
                  C PROPAGATE CLASSIFICATION THROUGHOUT ROW.                              ECH04260
                  C                                                                       ECH04270
   0234               I1 = 1 + (ROW-1)*ROWSIZ                                             ECH04280
   0235               I2 = I1 + ROWSIZ-CELSIZ                                             ECH04290
   0236               DO 3002 I3=I1,I2,CELSIZ                                             ECH04300
   0237               IF(BUFFER(I3) .NE. FIELD) GO TO 3002                                ECH04310
   0238               STOP = .FALSE.                                                      ECH04320
   0239               I4 = I3 + CELSIZ                                                    ECH04330
   0240               DO 3001 I5=I3,I4                                                    ECH04340
   0241          3001 BUFFER(I5) = CLASS2                                                 ECH04350
   0242          3002 CONTINUE                                                           ECH04360
   0243               IF(STOP .OR. ROW.EQ.PRTRW) GO TO RETURN, (250,420)                  ECH04370
   0244               ROW = ROW - 1                                                       ECH04380
   0245               GO TO 3000                                                          ECH04390
                  C                                                                       ECH04400
                  C PRINT ONE ROW OF CELLS                                                ECH04410
                  C                                                                       ECH04420
   0246          4000 I1 = 1 + (PRTRW-1)*ROWSIZ                                           ECH04430
   0247               I2 = I1 + CELSIZ - CELWTH                                           ECH04440
   0248               DO 4002 I3=I1,I2,CELWTH                                             ECH04450
   0249               I5 = 0                                                              ECH04460
   0250               I4 = I3 + ROWSIZ-CELSIZ                                             ECH04470
   0251               DO 4001 I6=I3,I4,CELSIZ                                             ECH04480
   0252               I7 = I6 + CELWTH - 1                                                ECH04490
   0253               DO 4001 I8=I6,I7                                                    ECH04500
   0254               I5 = I5 + 1                                                         ECH04510
   0255          4001 PRTBUF(I5) = BUFFER(I8) - JPTS2                                     ECH04520
   0256               WRITE(OUTPUT,ERR=600) PREFIX,PLINE,PRTBUF                           ECH04530
                  C                                                                       ECH04540
                  C CLASSIFICATION MAP                                                    ECH04550
                  C                                                                       ECH04560
```

FILE SECH01

```
0257              IF (.NOT. CLSMAP) GO TO 4002                                  ECH04570
0258              I = 1                                                         ECH04580
0259              K = INTVL*CELWTH                                              ECH04590
0260              LIN = PLINE + K - 1                                           ECH04600
0261              IF(MOD(LIN,K) .NE. 0) GO TO 4002                              ECH04610
0262              DO 4003 J = I,PTS,K                                           ECH04620
0263              PRTBUF(I) = HSYM(PRTBUF(J)*Z-1)                               ECH04630
0264              IF (I.GT.JPTS1) PRTBUF(I) = BLANK2                            ECH04640
0265              I = I + 1                                                     ECH04650
0266         4003 CONTINUE                                                      ECH04660
0267              WRITE(PRNTR,9400$)PLINE,(PRTBUF(I),I=1,JPTS1)                 ECH04670
0268        $4004 FORMAT(Q,1X,111A1)                                            ECH04680
0269         4002 PLINE = PLINE + LININT                                        ECH04690
0270              PRTRW = MOD(PRTRW,NUFROZ) + 1                                 ECH04700
0271              GO TO RETURN, (150,430,500)                                   ECH04710
0272              END                                                           ECH04720
```

LARS Program Abstract _____

MODULE IDENTIFICATION

Module Name: GATHER Function Name: ECHO FUNCTIONAL SUPPORT

Purpose: Gather cell statistics information for processing.

System/Language: CMS/FORTRAN

Author: P. D. Alenduff Date: 4/12/77

Latest Revisor: _____ Date: _____

MODULE ABSTRACT

GATHER computes information about cell statistics for actual classification by SECHO.

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West Lafayette, Indiana 47906

1. Module Usage

GATHER

CALL GATHER (RDATA, PIXVAL, PIXCOR, CELSUM, CELCOR, CELWTH, VECSIZ, MTXSIZ, NSR, NVR)

Input Arguments:

RDATA (NSR, NVR)	R*4 Calibrated data values from data tape with NSR samples and NVR channels.
CELWTH	I*4 Number of data points in width of cell.
VECSIZ	I*4 Number of channels to be used in classification.
MTXSIZ	I*4 Number of entries in the triangular covariance matrix. Equal to (channels * (channels + 1))/2.
NSR	I*4 Number of data samples per line in RDATA.
NVR	I*4 Number of channels of data in RDATA array.

Output Arguments:

PIXVAL (NOFET3, CELWTH*CELWTH)	R*4 An array of actual data values in the cell dimensioned channels by (cell width)^2.
PIXCOR (MTXSIZ, CELWTH*CELWTH)	R*4 Cross product terms for all data points in a cell, dimensioned (cell width)^2 by MTXSIZ.
CELSUM (VECSIZ)	R*4 Sum of data values in the cell for each channel of data (dimensioned channels).

CELCOR (MTXSIZ)	R*4 Correlation matrix for data values in cell consisting of a sum of products of data values in cell.

GATHER is called to return information concerning the data characteristics of one cell of data.

2. Internal Description

GATHER loops for each channel of data and each pixel within the cell to produce the data array returned.

3. Input Description

Not applicable

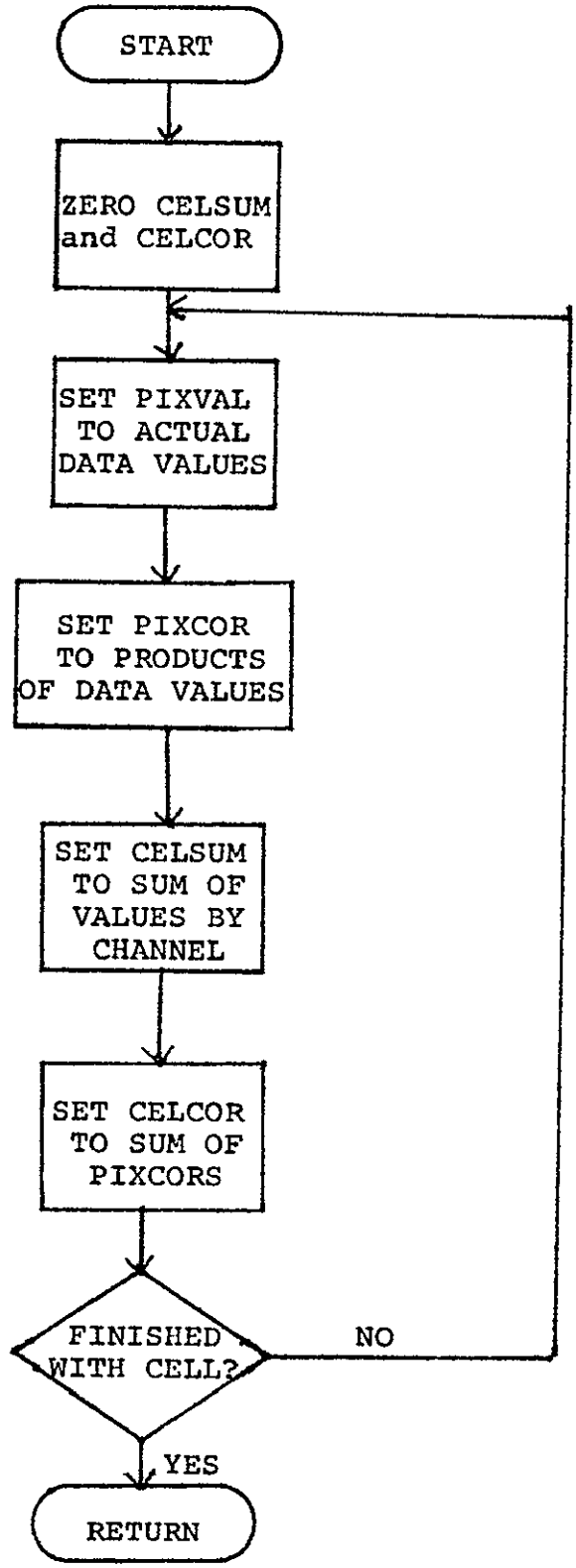
4. Output Description

Not applicable

5. Supplemental Information

Not applicable

6. Flowchart


START
ZERO CELSUM and CELCOR
SET PIXVAL TO ACTUAL DATA VALUES
SET PIXCOR TO PRODUCTS OF DATA VALUES
SET CELSUM TO SUM OF VALUES BY CHANNEL
SET CELCOR TO SUM OF PIXCORS
FINISHED WITH CELL?
NO
YES
RETURN

```
C    GATHER        LARS   XXXX                                                    GAT00010
C                  GATHER STATISTICS ON A GIVEN CELL                              GAT00020
C                                                                                 GAT00030
C*****************************************************************************GAT0004C
C=GATHER              REVISED 04/11/74  R.L.KETTIG                                GAT00050
C COMPUTE STATISTICS FOR THE CELL WHOSE FIRST DATA VALUE IS RDATA(1).              GAT00060
0001        SUBROUTINE GATHER(RDATA,PIXVAL,PIXCOR,CELSUM,CELCOR,CELWTH,VECSIZ,GAT00070
     &  MTXSIZ,NSR,NVR)                                                           GAT00080
0002        IMPLICIT INTEGER * 4 (A-Z)                                           GAT00090
0003        REAL*4 RDATA(1),PIXVAL(1),PIXCOR(1),CELSUM(VECSIZ),CELCOR(MTXSIZ)    GAT00100
0004        DO 10 L=1,VECSIZ                                                     GAT00110
0005     10 CELSUM(L) = 0.                                                       GAT00120
0006        DO 11 L=1,MTXSIZ                                                     GAT00130
0007     11 CELCOR(L) = 0.                                                       GAT00140
0008        N = CELWTH*MTXSIZ                                                    GAT00150
0009        J1 = 0                                                               GAT00160
0010        J2 = 0                                                               GAT00170
0011        L2 = 0                                                               GAT00180
0012        DO 4 J=1,CELWTH                                                      GAT00190
0013        K1 = J1                                                              GAT00200
0014        K2 = J2                                                              GAT00210
C J1 = (J-1)*NVR                                                                 GAT00220
C J2 = (J-1)*N                                                                   GAT00230
0015        DO 3 K=1,CELWTH                                                      GAT00240
0016        K1 = K1 + 1                                                          GAT00250
0017        M2 = 0                                                               GAT00260
0018        L1 = K1                                                              GAT00270
0019        K3 = L2                                                              GAT00280
C K1 = J1 + K                                                                    GAT00290
C K2 = J2 + (K-1)*MTXSIZ                                                         GAT00300
C K3 = (K-1)*VECSIZ + (J-1)*VECSIZ*CELWTH                                        GAT00310
0020        DO 2 L=1,VECSIZ                                                      GAT00320
0021        M1 = K3                                                              GAT00330
0022        L2 = L2 + 1                                                          GAT00340
C L1 = K + (L-1)*NSR + (J-1)*NVR                                                 GAT00350
C L2 = L + (K-1)*VECSIZ + (J-1)*VECSIZ*CELWTH                                    GAT00360
0023        PIXVAL(L2) = RDATA(L1)                                               GAT00370
0024        CELSUM(L) = CELSUM(L) + PIXVAL(L2)                                   GAT00380
0025        DO 1 M=1,L                                                           GAT00390
0026        M1 = M1 + 1                                                          GAT00400
0027        M2 = M2 + 1                                                          GAT00410
0028        M3 = K2 + M2                                                         GAT00420
C M1 = M + (K-1)*VECSIZ + (J-1)*VECSIZ*CELWTH                                    GAT00430
C M2 = M + L*(L-1)/2                                                             GAT00440
C M3 = M + L*(L-1)/2 + (K-1)*MTXSIZ + (J-1)*N                                    GAT00450
0029        PIXCOR(M3) = PIXVAL(M1)*PIXVAL(L2)                                   GAT00460
0030     1  CELCOR(M2) = CELCOR(M2) + PIXCOR(M3)                                 GAT00470
0031     2  L1 = L1 + NSR                                                        GAT00480
0032     3  K2 = K2 + MTXSIZ                                                     GAT00490
0033        J1 = J1 + NVR                                                        GAT00500
0034     4  J2 = J2 + N                                                          GAT00510
0035        RETURN                                                               GAT00520
0036        END                                                                  GAT00530
```

LARS Program Abstract _____

MODULE IDENTIFICATION

Module Name: FILBUF Function Name: SECSUP

Purpose: Retrieve cell statistics

System/Language: CMS/FORTRAN

Author: P. D. Alenduff Date: 4/18/77

Latest Revisor: _____ Date: _____

MODULE ABSTRACT

FILBUF returns a set of buffers with cell information from either direct processing from the data tape or reading from the intermediate tape.

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1. Module Usage

FILBUF

```
CALL FILBUF (ICLSCV, VECPRD, SCAPRD, SETCOV, CONST, BDATA,
             RDATA, PIXCOR, PIXVAL, CELCOR, CELSUM, CELIKE,
             CELCLS, PIXCLS, CURLIN, *)
```

Input Arguments:

ICLSCV (VARSZ3, NOPOOL)	R*4 Class covariance matrices from statistics dimensioned classes by (channels * (channels + 1))/2.
VECPRD (NOFET3, NOPOOL)	R*4 Vector product matrix that is inverse of class mean matrix transposed times the covariance matrix for the class, dimensioned channels by classes.
SCAPRD (NOPOOL)	R*4 Scalar product of the classes for all statistics classes.
DETCOV (NOPOOL)	R*4 Determinant of the covariance matrix for each class.
CONST (NOPOOL)	R*4 Constant array computed from ln (2*PI*class covariance matrix) for each class.
BDATA (NVR, ID(6))	L*1 Buffer array used by GADLIN for reading data tape dimensioned channels on tape by samples per line on tape.
RDATA (NVR, CELWTH)	R*4 Array used to store calibrated data values from tape for one row of cells (multiple data lines).

PIXCOR (VARSZ3, CELWTH^2)	R*4 Array used to store cross product data values in one cell for a correlation type indication.
PIXVAL (NOFET3, CELWTH^2)	R*4 Array used to store pixel data values for a cell.
CELCOR (VARSZ3)	R*4 Sum of the PIXCOR values for a cell being processed.

Output Arguments:

CELSUM (NOFET3)	R*4 The sum of all data points in a cell for each channel.
CELIKE (NWORD, JPTS)	R*4 Likelihood values for each class for each cell in a row of cells.
CELCLS (JPTS)	I*2 Class numbers for each cell in a row of cells.
PIXCLS (NWORDS, JPTS)	I*2 Class numbers of pixels for all cells in a row of cells.
CURLIN	I*4 Current line number requested.

FILBUF is called to fill up CELCLS and CELIKE for annexation or writing to the intermediate tape. By either reading from the intermediate tape for annexation processing, or reading from the data tape and carrying out processing for the area, cell information can be produced.

2. Internal Description

FILBUF produces arrays CELCLS and CELIKE from either reading the intermediate tape that is in a classification format or from reading the input data tape via GADLIN. The raw information is then processed by producing cell statistics with GATHER,

establishing cell classes with SAMCLS, testing for cell homogeneity, and outputing a row of cell information. This routine uses common blocks GLOCOM and SECCOM.

3. Input Description

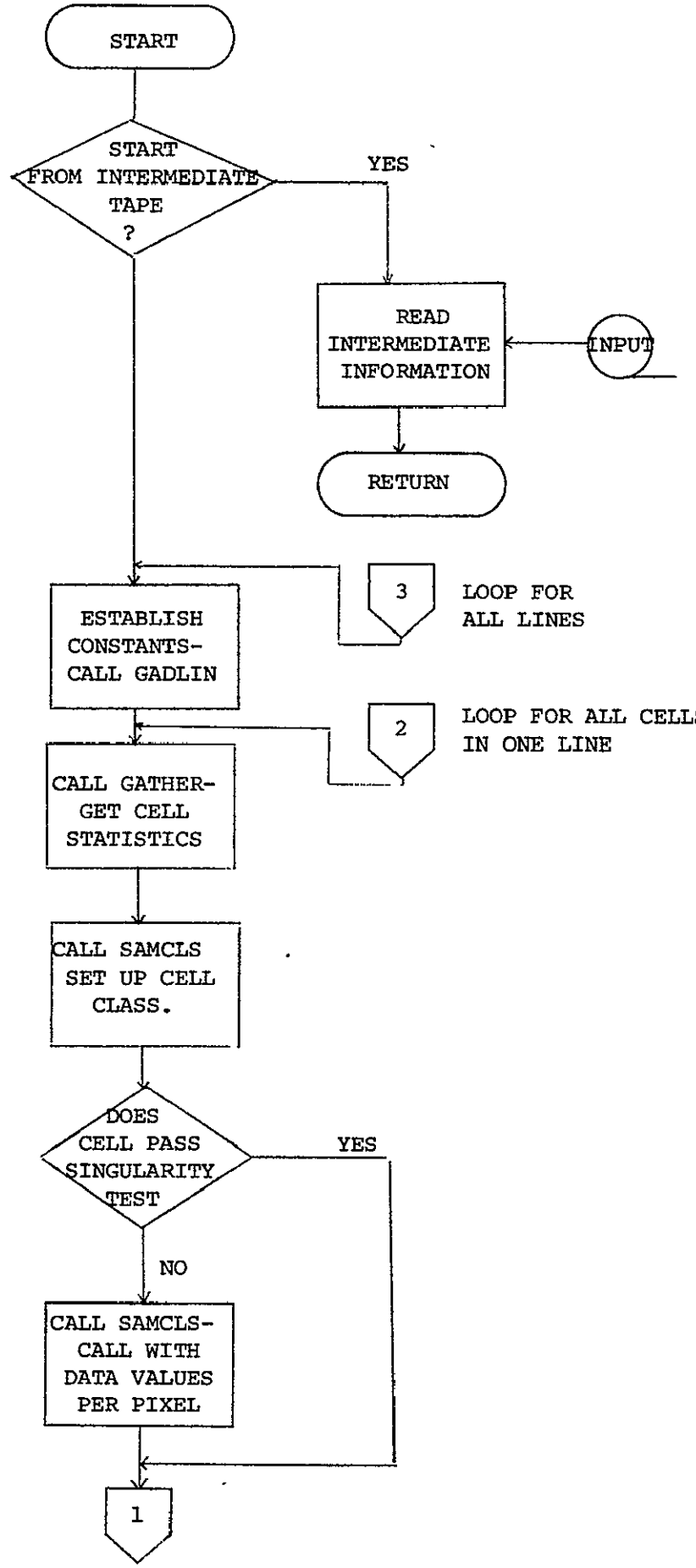
The only input is possible input from the intermediate tape which stores the same format used by classification tapes and stores cell statistics for later annexation processing.

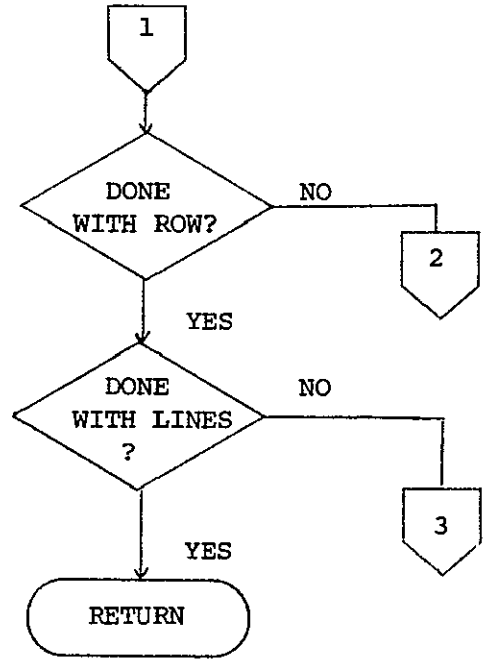
4. Output Description

Not applicable.

5. Supplemental Information

Not applicable.


START
START FROM INTERMEDIATE TAPE ?
YES
READ INTERMEDIATE INFORMATION
INPUT
RETURN
3
LOOP FOR ALL LINES
ESTABLISH CONSTANTS- CALL GADLIN
2
LOOP FOR ALL CELLS IN ONE LINE
CALL GATHER- GET CELL STATISTICS
CALL SAMCLS SET UP CELL CLASS.
DOES CELL PASS SINGULARITY TEST
YES
NO
CALL SAMCLS- CALL WITH DATA VALUES PER PIXEL
1


1
DONE WITH ROW?
NO
2
YES
DONE WITH LINES ?
NO
3
YES
RETURN

REPRODUCIBILITY OF THE
ORIGINAL PAGE IS POOR

FILE FILBUF

```
                C   FILBUF   LARS   XXXX                                                    FIL00010
                C                                                                           FIL00020
                C***********************************************************************FIL00030
                C                                                                           FIL00040
                C RETURNS CELCLS AND CELIKE VALUES FROM EITHER DATA TAPE OR INTER           FIL00050
                C         MEDIATE TAPE                                                      FIL00060
                C                                                                           FIL00070
                C***********************************************************************FIL00080
                C                                                                           FIL00090
0001                 SUBROUTINE FILBUF (ICLSCV, VECPRD, SCAPRD, DETCOV, CONST,          FIL00100
                    & BDATA, RDATA, PIXCOR, PIXVAL, CELCOR, CELSUM, CELIKE, CELCLS,     FIL00110
                    & PIXCLS,CURLIN)                                                    FIL00120
                C                                                                           FIL00130
0002                 IMPLICIT INTEGER * 4 (A-Z)                                         FIL00140
                C                                                                           FIL00150
0003                 COMMON /GLOCOM/ BLANK, CARD(20), CHKOUT, COPFIL, CLASSR, CLASSX,   FIL00160
                    1    CLUSTX, CONPUT, CPYOUT, CRDRDR, CRDSEQ, DATAPE,                FIL00170
                    2    DUPLTP, DUPRUN, ERRMSG, F8PNT,                                 FIL00180
                    3    FILESV, FLDBND, HDATA, HEAD(88), ID(200), IMAGEX,              FIL00190
                    4    IMARK, KEYBD, MAPTAP, MAXCHA, MAXCLS,                          FIL00200
                    5    PAGSIZ, PNCH, POINT, PRESUX, PRNTR, READIN,                    FIL00210
                    6    RESTRT, RLNFIL, RUNTAB(10,3),                                  FIL00220
                    7    SDATA, SEPARX, SEPTPX, SPARE(10), TEMPAS(30),                  FIL00230
                    8    TPSTAT(6), TTFLDX ,TYPEWR,                                     FIL00240
                    9    TOP, ARRAY(12500)                                              FIL00250
                C                                                                           FIL00260
0004                 REAL * 8 ARRAY                                                     FIL00270
0005                 REAL * 4 FROCAL(5,30)                                              FIL00280
0006                 INTEGER * 4 COMENT(16), DATE(5), HED1(16), HED2(16), TIME(5)       FIL00290
0007                 INTEGER * 2 BLANK2                                                 FIL00300
0008                 LOGICAL * 4 CHKOUT                                                 FIL00310
0009                 LOGICAL * 1 BLANK1                                                 FIL00320
0010                 EQUIVALENCE (DATSAV,ID(1)), (CURRUN,ID(3)), (FROCAL(1),ID(51)),    FIL00330
                    1        (HED1(1),HEAD(8)), (DATE(1),HEAD(26)), (HED2(1),HEAD(39)),FIL00340
                    2        (TIME(1),HEAD(58)), (COMENT(1),HEAD(72)),                  FIL00350
                    3        (MAPSAV,TPSTAT(1)),                                        FIL00360
                    4        (SEPSCR,TPSTAT(2)), (DUPIN,TPSTAT(3)), (DASTAT,TPSTAT(4)),FIL00370
                    5        (CCPSER,TPSTAT(5)), (TRAOUT,TPSTAT(6)),                    FIL00380
                    6        (BLANK,BLANK2,BLANK1)                                      FIL00390
                C                                                                           FIL00400
0011                 COMMON /SECCOM/ BUFROZ,CSELEC,CSET(3,30),CSET3(3,30),THRES,CELSIZ,FIL00410
                    1 CELWTH,INFO(17),INPUT, INTTAP, INTFIL, JPTS, LINES, NOCLS, NOFET,FIL00420
                    2 NOFET3,NOPOOL,NWCRD,NWORD2, NVR, OUTPUT, POLNAM(2,60), PREFIX(2),FIL00430
                    3 PTS, ROTAPE, ROFILE, SYMCNT, VARSZ3, CSEL(30), CSEL3(30),        FIL00440
                    3 FETVEC(30), FETVC3(30), POLPTR(2,60), POLSTK(60),                FIL00450
                    4 CDFLAG, CLSMAP, CSET1(3,30), OBJMAP, PHASE1, PHASE2, POLNM1(60), FIL00460
                    5 PRSTAT, SYM(60), SYMMTX(60)                                      FIL00470
                C                                                                           FIL00480
0012                 REAL * 4 CSELEC, CSET, CSET3, THRES                                FIL00490
                C                                                                           FIL00500
0013                 INTEGER * 2 CSEL, CSEL3, FETVEC, FETVC3, POLPTR, POLSTK            FIL00510
                C                                                                           FIL00520
0014                 LOGICAL * 1 CDFLAG, CLSMAP, CSET1, OBJMAP, PHASE1, PHASE2, POLNM1,FIL00530
                    1 PRSTAT                                                           FIL00540
                C                                                                           FIL00550
                C                                                                           FIL00560
                C                                                                           FIL00570
                C                                                                           FIL00580
                C                                                                           FIL00590
                C  LOCAL VARIABLES                                                          FIL00600
                C                                                                           FIL00610
0015                 INTEGER*2 BLOCK(4),CELCLS(JPTS),PIXCLS(NWORD2,JPTS),               FIL00620
                    1 BDATA(1)                                                         FIL00630
0016                 REAL * 4 ICLSCV(VARSZ3,NOPOOL), VECPRD(NOFET3,NOPOOL),             FIL00640
                    1 SCAPRD(NOPOOL),DETCOV(NOPOOL),CONST(NOPOOL),CELSUM(NOFET3),      FIL00650
                    2 CELCOR(VARSZ3),PIXVAL(1),PIXCOR(1),CELIKE(NWORD,JPTS),           FIL00660
                    3 RDATA(NVR,CELWTH),CHISQR,AI                                      FIL00670
                C                                                                           FIL00680
                C                                                                           FIL00690
                C INITIALIZE                                                                FIL00700
                C                                                                           FIL00710
0017                 ERRFG = 0                                                          FIL00720
0018                 DO 100 I=2,4                                                       FIL00730
0019            100 BLOCK(I) = INFO(I+5)                                                FIL00740
                C                                                                           FIL00750
                C GLCR = NUMBER OF DATA LINES TO SKIP TO GET NEXT CELL DATA LINE            FIL00760
```

FILE FILBUF

```
                C                                                                       FIL00770
0020                 NSR = NVR/NOFET3                                                   FIL00780
                C                                                                       FIL00790
                C***********************************************************************FIL00800
                C                                                                       FIL00810
                C ENTER MAIN LOOP                                                       FIL00820
                C                                                                       FIL00830
                C***********************************************************************FIL00840
                C                                                                       FIL00850
                C GET ONE ROW OF DATA FOR CELLS (MAY BE MORE THAN ONE LINE)             FIL00860
                C                                                                       FIL00870
0021                 IF (PHASE2 .AND. .NOT. PHASE1) GO TO 400                           FIL00880
0022                 I = CURLIN                                                         FIL00890
0023                 DO 155 J=1,CELWTH                                                  FIL00900
0024                 BLOCK(1) = I                                                       FIL00910
0025                 CALL GADLIN(BLOCK,CSEL3,CSET3,ID,DATAPE,NOFET3,NSR,BDATA,          FIL00920
                    & RDATA(1,J),ROLL,ERROR)                                            FIL00930
0026                 IF(ERROR.GT.0) CALL LINERR(ERROR,I,&810,&155,&810)                 FIL00940
0027            155  I = I + INFO(6)                                                    FIL00950
0028                 H  = 1                                                             FIL00960
                C                                                                       FIL00970
                C GET CELL DATA ARRAYS UPDATED FOR EACH CELL IN LINE                    FIL00980
                C                                                                       FIL00990
0029                 DO 200 CELNUM=1,JPTS                                               FIL01000
0030                 CALL GATHER(RDATA(H,1),PIXVAL,PIXCOR,CELSUM,CELCOR,CELWTH,         FIL01010
                    & NOFET3,VARSZ3,NSR,NVR)                                            FIL01020
                C                                                                       FIL01030
                C CLASSIFY EACH CELL WITH MAXIMUM LIKELIHOOD AND RETURN CHI-SQUARE       FIL01040
                C       VALUE FOR THRESHOLDING HOMOGENEOUS DEFINITION                   FIL01050
                C                                                                       FIL01060
0031                 CALL SAMCLS(CLASS,CHISQR,CELIKE(1,CELNUM),ICLSCV,VECPRD,           FIL01070
                   &SCAPRD,CONST,CELCOR,CELSUM,CELSIZ,NOFET3,VARSZ3,NOPOOL,.TRUE.)      FIL01080
0032                 CELCLS(CELNUM) = CLASS                                             FIL01090
0033                 IF (CHISQR .LE. CSELEC) GO TO 200                                  FIL01100
                C                                                                       FIL01110
                C NON HOMOGENEOUS CELL.  CLASSIFY VECTORS SEPARATELY.                   FIL01120
                C                                                                       FIL01130
0034                 L = 1                                                              FIL01140
0035                 M = 1                                                              FIL01150
0036                 CELCLS(CELNUM) = 0                                                 FIL01160
0037                 DO 196 PIXNUM=1,CELSIZ                                             FIL01170
                C                                                                       FIL01180
                C TRY AGAIN                                                             FIL01190
                C                                                                       FIL01200
0038                 CALL SAMCLS(CLASS,CHISQR,A1,ICLSCV,VECPRD,SCAPRD,CONST,            FIL01210
                    & PIXCOR(M),PIXVAL(L),1,NOFET3,VARSZ3,NOPOOL,.FALSE.)               FIL01220
0039                 PIXCLS(PIXNUM,CELNUM) = CLASS                                      FIL01230
0040                 L = L + NOFET3                                                     FIL01240
0041            196  M = M + VARSZ3                                                     FIL01250
0042            200  H = H + CELWTH                                                    FIL01260
0043                 GO TO 210                                                          FIL01270
                C***********************************************************************FIL01280
                C                                                                       FIL01290
                C READ FROM INPUT INTERMEDIATE TAPE                                     FIL01300
                C                                                                       FIL01310
                C***********************************************************************FIL01320
0044            400  READ(INPUT,ERR=810)PREFIX,I,CELCLS,CELIKE                         FIL01330
0045                 IF (I .LT. CURLIN) GO TO 400                                       FIL01340
0046            210  RETURN                                                           FIL01350
                C                                                                       FIL01360
                C***********************************************************************FIL01370
                C                                                                       FIL01380
                C ERROR PROCESSING                                                      FIL01390
                C                                                                       FIL01400
                C***********************************************************************FIL01410
                C                                                                       FIL01420
0047            810  WRITE(PRNTR,9810) CURLIN                                         FIL01430
0048           9810  FORMAT('0READ ERROR FROM GADLIN.  CURRENT LINE NO. IS ',I4//      FIL01440
                    & ' PROCESSING TERMINATED.')                                        FIL01450
0049                 ERRFG = 1                                                          FIL01460
0050                 GO TO 210                                                          FIL01470
0051                 END                                                            FIL01480
```

LARS Program Abstract _____

MODULE IDENTIFICATION

Module Name: STATS2 Function Name: SECSUP

Purpose: Carry out annexation tests and processing

System/Language: CMS/FORTRAN

Author: P. D. Alenduff Date: 4/20/77

Latest Revisor: _____ Date: _____

MODULE ABSTRACT

STATS2 contains entry points LIKRAT, ADD2, and BEGFLD. LIKRAT produces a likelihood test by subtracting log - likelihoods and returns a resultant likelihood value. ADD2 adds a cell to the statistics of a field. BEGFLD initializes field statistics from a fields statistics.

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1. Module Usage

LIKRAT

```
CALL LIKRAT (STAT, CELIKE, FLDLIK, AUXLIK, CELCLS, FLDCLS,
             AUXCLS)
```

Input Arguments:

CELIKE (NOPOOL)	R*4 Log likelihood values for this cell for each class in the statistics.
FLDLIK (NOPOOL)	R*4 Log likelihood values of all cells annexed to the field for each class in the statistics.
CELCLS	I*2 Class number of cell being considered.
FLDCLS	I*2 Class number of field being tested.

Output Arguments:

AUXLIK (NOPOOL)	R*4 Resultant log likelihood of annexation of cell to given field for each class.
AUXCLS	I*2 Resultant class of annexation test for this cell.
STAT	R*4 Resulting statistic concerning annexation performance for this cell to the field being considered.

LIKRAT produces a resulting likelihood, class and statistic if the given cell is annexed to the supplied field.

ADD2

```
CALL ADD2 (FLDLIK, AUXLIK, FLDCLS, AUXCLS, FLDSIZ)
```

Input Arguments:

AUXLIK (NOPOOL)	R*4 Likelihood values formed with temporary annexation of cell to field.
AUXCLS	I*2 Class number of cell when annexation of cell to field was successful.
FLDSIZ	I*4 Number of pixels included in the given field.

Output Arguments:

FLDLIK (NOPOOL)	R*4 Likelihood values of new field formed.
FLDCLS	I*2 Class of field formed.
FLDSIZ	I*4 (see above).

ADD2 adds the cell supplied to the field information supplied. Temporary likelihood values are assigned as new likelihoods for field.

BEGFLD

CALL BEGFLD (CELCLS, FLDCLS, CELIKE, FLDLIK, FLDSIZ)

Input Arguments:

CELCLS	I*2 See above.
CELIKE (NOPOOL)	R*4 See above.

Output Arguments:

FLDCLS	I*2 See above.
FLDLIK (NOPOOL)	R*4 See above.
FLDSIZ	I*4 See above.

BEGFLD initialize FLDCLS, FLDLIK, and FLDSIZ to be equal to CELCLS, CELIKE, and CELSIZ.

2. Internal Description

See above.

3. Input Description

Not applicable

4. Output Description

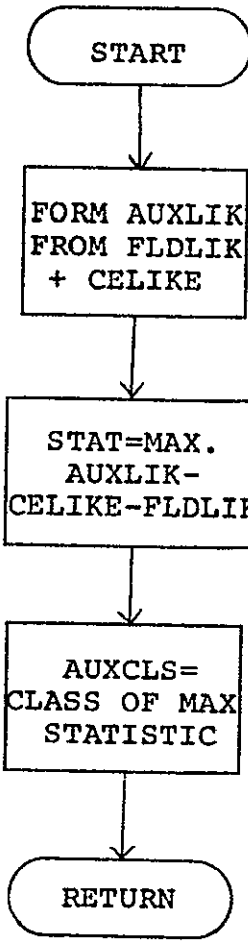
Not applicable

5. Supplemental Information

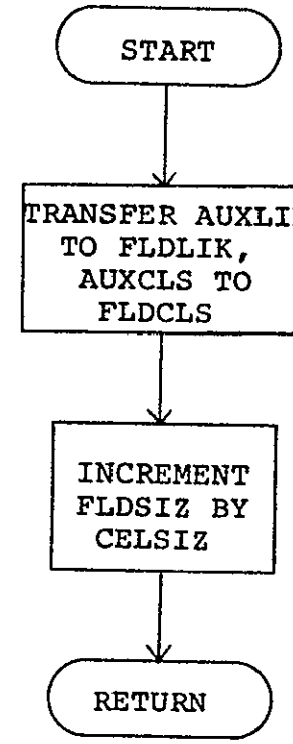
Not applicable

6. Flowchart

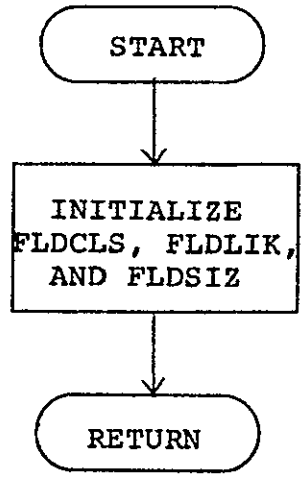
LIKRAT



ADD2



BEGFLD



FILE STATS2

```
C       STATS2      LARS  XXXX                                                  ECH00010
C                                                                               ECH00020
C*****************************************************************************ECHC0030
C                                                                               ECH00040
C THIS SUBROUTINE WAS WRITTEN TO HELP IMPLEMENT A MORE COMPLEX SCANNING         ECHC0050
C LOOP THAN THE ONE IN THE ORIGINAL ECHC.  ESSENTIALLY IT DOES WHAT             ECHCC060
C ANNEX DOES, BUT IT OPERATES ONLY IN SUPERVISED MODE OF ANNEXATION.            ECHCCC7C
C                                                                               ECHCC080
C*****************************************************************************ECHCC090
C                                                                               ECH00100
      SUBROUTINE STATS2                                                         ECH00110
      IMPLICIT INTEGER * 4 (A-Z)                                                ECH00120
C                                                                               ECH00130
      COMMON /SECCOM/ BUFROZ,CSELEC,CSET(3,30),CSET3(3,30),THRES,CELSIZ,        ECHC0140
     1 CELWTH,INFO(17),INPUT, INTTAP, IPTFIL, JPTS, LINES, NOCLS, NOFET,        ECHC0150
     2 NOFET3,NOPOOL,NWCRD,NWORD2, NVR, OUTPUT, POLNAM(2,60), PREFIX(2),        ECH00160
     3 PTS, ROTAPE, ROFILE, SYMCNT, VARSZ3, CSEL(30), CSEL3(30),                ECH00170
     3 FETVEC(30), FETVC3(30), POLPTR(2,60), POLSTK(60),                        ECHC0180
     4 CDFLAG, CLSMAP, CSET1(3,30), OBJMAP, PHASE1, PHASE2, POLNM1(60),         ECHC019C
     5 PRSTAT, SYM(60), SYMMTX(60)                                              ECH00200
C                                                                               ECH00210
      REAL * 4 CSELEC, CSET, CSET3, THRES                                       ECH00220
C                                                                               ECHC0230
      INTEGER * 2 CSEL, CSEL3, FETVEC, FETVC3, POLPTR, POLSTK                   ECH00240
C                                                                               ECH00250
      LOGICAL * 1 CDFLAG, CLSMAP, CSET1, OBJMAP, PHASE1, PHASE2, POLNM1,        ECHC0260
     1 PRSTAT                                                                   ECH00270
C                                                                               ECH00280
      REAL * 4 ANN1                                                             ECH00290
C                                                                               ECH00300
      REAL * 4 STAT,CELIKE(NOPOOL),FLDLIK(NOPOOL),AUXLIK(NOPOOL)                ECH00310
      INTEGER*2 CELCLS,FLDCLS,AUXCLS                                            ECH00320
C                                                                               ECH00330
      ENTRY LIKRAT(STAT,CELIKE,FLDLIK,AUXLIK,CELCLS,FLDCLS,AUXCLS)              ECHC0340
      DO 20 I=1,NOPOOL                                                          ECH00350
      AUXLIK(I) = CELIKE(I) + FLDLIK(I)                                         ECHC0360
      IF(I .EQ. 1) GO TO 10                                                     ECH00370
      IF(AUXLIK(I) .LE. STAT) GO TO 20                                          ECHC0380
   10 STAT = AUXLIK(I)                                                          ECH00390
      AUXCLS = I                                                                ECH00400
   20 CONTINUE                                                                  ECH00410
      STAT = STAT - CELIKE(CELCLS) - FLDLIK(FLDCLS)                             ECHC0420
      RETURN                                                                    ECH00430
C                                                                               ECH00440
      ENTRY ADD2(FLDLIK,AUXLIK,FLDCLS,AUXCLS,FLDSIZ)                            ECH00450
   50 DO 60 I=1,NOPOOL                                                          ECHC0460
   60 FLDLIK(I) = AUXLIK(I)                                                     ECHC0470
      FLDCLS = AUXCLS                                                           ECH00480
      FLDSIZ = FLDSIZ + CELSIZ                                                  ECH00490
      RETURN                                                                    ECH00500
C                                                                               ECH00510
C-ENTRY FOR FIELD INITIALIZATION.                                               ECH00520
C                                                                               ECH00530
      ENTRY BEGFLD(CELCLS,FLDCLS,CELIKE,FLDLIK,FLDSIZ)                          ECH00540
      FLDCLS = CELCLS                                                           ECH00550
      FLDSIZ = CELSIZ                                                           ECH00560
      DO 40 I=1,NOPOOL                                                          ECH00570
   40 FLDLIK(I) = CELIKE(I)                                                     ECH00580
      RETURN                                                                    ECH00590
      END                                                                       ECH00600
```

REPRODUCIBILITY OF THE
ORIGINAL PAGE IS POOR

LARS Program Abstract _____

MODULE IDENTIFICATION

Module Name: SAMCLS **Function Name:** SECSUP

Purpose: Classify cell using maximum likelihood

System/Language: CMS/FORTRAN

Author: P. D. Alenduff **Date:** 4/14/77

Latest Revisor: _____ **Date:** _____

MODULE ABSTRACT

SAMCLS performs a maximum likelihood classification by calling LOGLIK and finding the maximum likelihood class for a cell.

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1. Module Usage

SAMCLS

```
CALL SAMCLS (CLASS, CHISQR, LIKELY, COVMTX, VECPRD, SCAPRD,
             CONST, SAMCOR, SAMSUM, SAMPTS, NOFET3, MTXSIZ,
             NOPOOL, RETLIK)
```

Input Arguments:

COVMTX (VARSZ3, NOPOOL)	R*4 An array dimensioned (channels * (channels + 1)/2) * number of classes, containing the upper half of the triangular covariance matrices for each of the classes used for classification.
VECPRD (NOFET3, NOPOOL)	R*4 An array dimensioned channels * classes containing the vector product of the classes for each channel from the inverse covariance matrix and the determinant of the covariance matrix.
SCAPRD (NOPOOL)	R*4 An array dimensioned classes for the scalar product of the mean and covariance matrices for each class.
CONST (NOPOOL)	R*4 An array dimensioned "classes" words containing the constant term used consisting of an expression.
SAMSUM (NOFET3)	R*4 Sum of data values for all points in cell for given channel.
SAMPTS	I*4 Number of points per cell.
NOFET3	I*4 Number of channels.
MTXSIZ	I*4 Number of words needed to store

	half of triangular covariance matrix.
NOPOOL	I*4 Number of classification pools.
RETLIK	L*4 Indication of whether or not likelihoods are to be returned in LIKELY.

Output Arguments:

CLASS	I*4 Class number of cell.
CHISQR	R*4 Resultant Chi-square value from LOGLIK and classification.
LIKELY (NOPOOL)	R*4 Log likelihood of cell belonging to pools.

2. Internal Description

SAMCLS calls LOGLIK once for each class and is returned a log likelihood for the cell for each class. If the likelihood is greater than the previously stored, the new likelihood is saved with the class number and, when done, this class and value are returned.

3. Input Description

Not applicable.

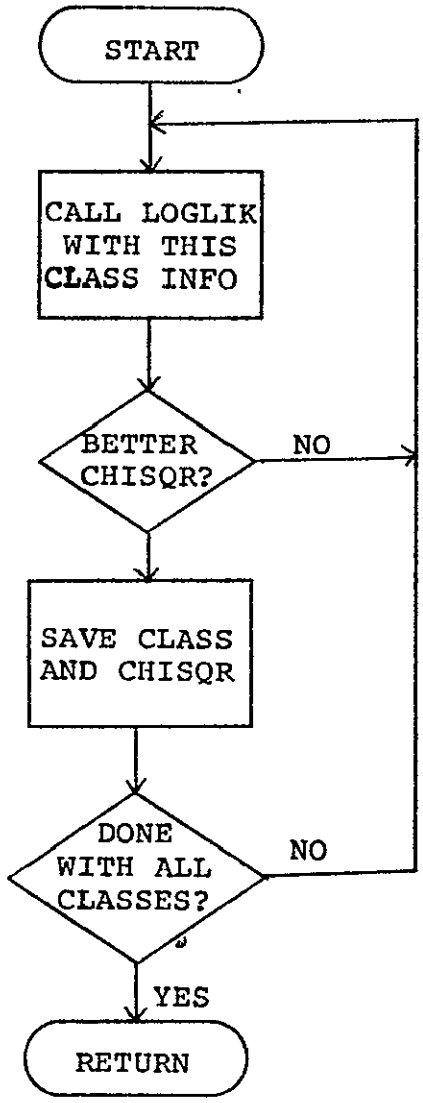
4. Output Description

Not applicable.

5. Supplemental Information

Not applicable.

6. Flowchart


START
CALL LOGLIK WITH THIS CLASS INFO
BETTER CHISQR?
NO
SAVE CLASS AND CHISQR
DONE WITH ALL CLASSES?
NO
YES
RETURN

FILE SAMCLS

```
      C   SAMCLS      LARS   XXXX                                                  SAM00010
      C                PROVIDES LIKELIHOOD CLASSIFICATION OF CELLS                SAM00020
      C                                                                           SAM00030
      C***************************************************************************SAM00040
      C                                                                           SAM00050
      C                REVISED 05/01/77 BY P.D. ALENDUFF                          SAM00060
      C                                                                           SAM00070
      C                                                                           SAM00080
      C***************************************************************************SAM00090
0001        SUBROUTINE SAMCLS(CLASS,CHISQR,LIKELY,ICLSCV,VECPRD,SCAPRD,CONST,   SAM00100
     &  SAMCOR, SAMSUM, SAMPTS, VECSIZ, MTXSIZ, NUMCLS, RETLIK)                   SAM00110
      C                                                                           SAM00120
0002        IMPLICIT INTEGER * 4 (A-Z)                                          SAM00130
      C                                                                           SAM00140
0003        REAL * 4 CHISQR,ICLSCV(MTXSIZ,NUMCLS),VECPRD(VECSIZ,NUMCLS),        SAM00150
     &  SCAPRD(NUMCLS),CONST(NUMCLS),SAMCOR(MTXSIZ),SAMSUM(VECSIZ),A,B,C,        SAM00160
     &  LIKELY(NUMCLS)                                                            SAM00170
      C                                                                           SAM00180
0004        LOGICAL * 4 RETLIK                                                  SAM00190
      C                                                                           SAM00200
0005        DO 2 I=1,NUMCLS                                                     SAM00210
0006        CALL LOGLIK(B,C,ICLSCV(1,I),VECPRD(1,I),SCAPRD(I),CONST(I),         SAM00220
     &  VECSIZ,SAMCOR,SAMSUM,SAMPTS)                                              SAM00230
0007        IF(RETLIK) LIKELY(I)=B                                              SAM00240
0008        IF (I.EQ.1) GO TO 1                                                 SAM00250
0009        IF (B.LE.A) GO TO 2                                                 SAM00260
0010      1 A=B                                                                 SAM00270
0011        CHISQR = C                                                          SAM00280
0012        CLASS = I                                                           SAM00290
0013      2 CONTINUE                                                            SAM00300
0014        RETURN                                                              SAM00310
0015        END                                                                 SAM00320
```

LARS Program Abstract _____

MODULE IDENTIFICATION

Module Name: LOGLIK Function Name: SECSUP

Purpose: Produce Log likelihood of a cell

System/Language: CMS/FORTRAN

Author: P. D. Alenduff Date: 4/13/77

Latest Revisor: _____ Date: _____

MODULE ABSTRACT

LOGLIK produces a log likelihood for a class in the input statistics.

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1. Module Usage

LOGLIK

CALL LOGLIK (LIKELY, CHISQR, ICLSCV, VECPRD, SCAPRD, CONST, DIMEN, SAMCOR, SAMSUM, SAMPTS)

Input Arguments:

ICLSCV (MTXSIZ)	R*4 Class covariance matrix from statistics, dimensioned channels * (channels + 1)/2.
VECPRD (DIMEN)	R*4 Vector product of class covariance matrix determinant and means dimensioned "channels" words.
SCAPRD	R*4 The scalar product term for the class being considered.
CONST	R*4 The constant term derived in SECPRT.
DIMEN	I*4 Number of channels of data in cell information.
SAMCOR (MTXSIZ)	R*4 The cross product terms from the cells data values dimensioned as ICLSCV.
SAMSUM (DIMEN)	R*4 The sum of the data values for each channel for the cell.
SAMPTS	I*4 Number of data points in a cell, actually (cell width)^2.

Output Arguments:

LIKELY	R*4 Log likelihood value for the cell.
CHISQR	R*4 Chi-square value returned for the cell.

LOGLIK is called to return a log likelihood and a Chi-square value for the cell being considered.

2. Internal Description

The Chi-square value is calculated by the equation:

$$CHISQR = tr(C_j^{-1} \sum_{i}^{m} Y_i Y_i') - 2M_j' C_j^{-1} \sum_{i}^{m} Y_i + mM_j' C_j^{-1} M_j$$

and the log likelihood is calculated by:

$$LIKELY = -.5 \ (m \cdot \ln|2\pi C_j| + CHISQR)$$

Where:

C_j is the class covariance matrix for class j.

M_j is the mean vector for class j.

Y_i is the channel response vector for pixel i of the cell.

m is the number of pixels in the cell.

3. Input Description

Not applicable.

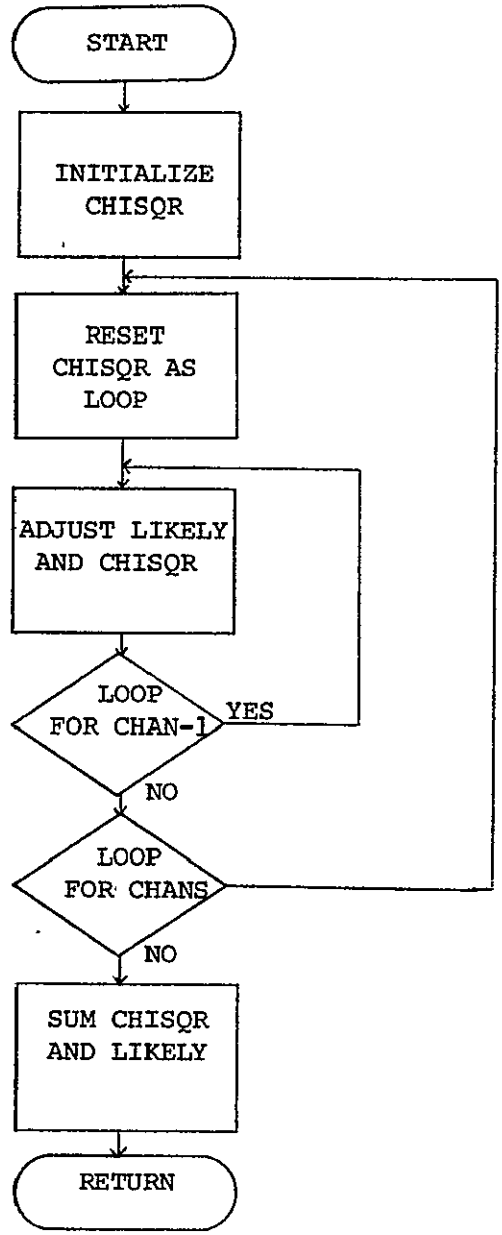
4. Output Description

Not applicable.

5. Supplemental Information

Not applicable.

6. Flowchart


START
INITIALIZE CHISQR
RESET CHISQR AS LOOP
ADJUST LIKELY AND CHISQR
LOOP FOR CHAN-1
YES
NO
LOOP FOR CHANS
NO
SUM CHISQR AND LIKELY
RETURN

FILE LOGLIK

```
                C LOGLIK    LARS   XXXX                                                          LOG00010
                C                                                                                LOG00020
                C*******************************************************************************LOG00030
                C                                                                                LOG00040
   0001               SUBROUTINE LOGLIK(LIKELY,CHISQR,ICLSCV,VECPRD,SCAPRD,CONST,DIMEN,         LOG00050
                     & SAMCOR, SAMSUM, SAMPTS)                                                   LOG00060
                C                                                                                LOG00070
                CC                                                                               LOG00080
                CC     LOCAL VARIABLES                                                           LOG00090
                CC                                                                               LOG00100
                C DIMEN = NUMBER OF CHANNELS USED                                                LOG00110
                C SAMPTS = NUMBER OF PTS PER CELL                                                LOG00120
                C CONST = LN(2*PI*C(N)) WHERE C(N) IS COVARIANCE MATRIX                          LOG00130
                C         FOR CLASS N (N IS DETERMINED BY SAMCLS)                                LOG00140
                C SAMSUM = SUM OF Y(I)                                                           LOG00150
                C SAMCOR = SUM OF Y(I)*Y(I) TRANSPOSED                                           LOG00160
                C ICLSCV = C(J) ** -1                                                            LOG00170
                C SCAPRD = M(J)*C(J) TRANSPOSED *M(J) WHERE C(J) = CLASS                         LOG00180
                C          COVARIANCE MATRIX AND M(J) = CLASS MEAN MATRIX                        LOG00190
                C VECPRD = M(J) TRANSPOSE * C(J) ** -1                                           LOG00200
                C                                                                                LOG00210
                C*******************************************************************************LOG00220
                C                                                                                LOG00230
   0002               IMPLICIT INTEGER * 4 (A-Z)                                                LOG00240
   0003               REAL * 4 LIKELY,CHISQR,ICLSCV(1),VECPRD(DIMEN),SCAPRD,CONST,              LOG00250
                     &         SAMCOR(1), SAMSUM(DIMEN)                                        LOG00260
   0004               K = 1                                                                     LOG00270
   0005               LIKELY = 0                                                                LOG00280
                C                                                                                LOG00290
                C SET CHISQR = .5 * NO. OF POINTS/CELL * LN(2*PI*DET(CLS COVAR MTX))             LOG00300
                C                                                                                LOG00310
   0006               CHISQR = .5 * SAMPTS * SCAPRD-VECPRD(1)*SAMSUM(1)+.5*ICLSCV(1)*SAMLOG00320
                     1COR(1)                                                                     LOG00330
                C                                                                                LOG00340
   0007               DO 2 I = 2,DIMEN                                                          LOG00350
   0008               CHISQR = CHISQR - VECPRD(I)*SAMSUM(I)                                     LOG00360
   0009               L = I - 1                                                                 LOG00370
   0010               DO 1 J=1,L                                                                LOG00380
   0011               K = K+1                                                                   LOG00390
   0012             1 CHISQR = CHISQR + ICLSCV(K)*SAMCOR(K)                                     LOG00400
   0013               K = K + 1                                                                 LOG00410
   0014             2 LIKELY = LIKELY + ICLSCV(K) * SAMCOR(K)                                   LOG00420
   0015               CHISQR = CHISQR + .5*LIKELY                                               LOG00430
                C                                                                                LOG00440
                C AT THIS POINT, CHISQR = .5 * SAMPTS * SCAPRD + .5 * TRACE (ICLSCV*           LOG00450
                CC                              SAMCOR) - VECPRD*SAMSUM                          LOG00460
                C                                                                                LOG00470
   0016               LIKELY = -SAMPTS*CONST - CHISQR                                           LOG00480
   0017               CHISQR = CHISQR + CHISQR                                                  LOG00490
   0018               RETURN                                                                    LOG00500
   0019               END                                                                       LOG00510
```

LARS Program Abstract _____

MODULE IDENTIFICATION

Module Name: SECRD Function Name: SECSUP

Purpose: Read data arrays from intermediate tape.

System/Language: CMS/Fortran

Author: P. D. Alenduff Date: 4/12/77

Latest Revisor: _____ Date: _____

MODULE ABSTRACT

SECRD reads data arrays from the intermediate tape for annexation processing by SECHO.

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1. Module Usage

SECRD

CALL SECRD (COVMTX, AVEMTX)

Input Arguments:

COVMTX (VARSZ3, NOPOOL)	R*4 An array dimensioned (channels * (channels + 1))/2 fullwords for storing the covariance matrices of classes used in classification.
AVEMTX (NOPET3, NOPOOL)	R*4 An array dimensioned channels by classes words for storing the class means of classes used in the classification.

Output Arguments:

Same as above.

SECRD is called to read one reocrd from the intermediate tape. COVMTX and AVEMTX are read in an unformatted fashion from the unit INPUT. This program uses common blocks GLOCOM and SECCOM.

2. Internal Description

See above.

3. Input Description

SECRD reads from unit INPUT a record type 4 from the classification format file.

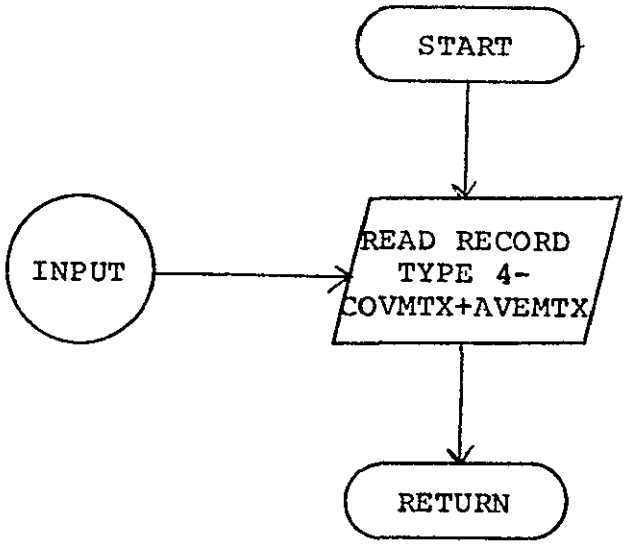
4. Output Description

Not applicable.

5. Supplemental Information

See LARSYS Systems Manual for format of classification results file.

6. Flowchart



FILE SECRD

```
C     SECRD    LARS   XXXX                                                    SEC00010
C                                                                             SEC00020
C*************************************************************************SEC00030
C                                                                             SEC00040
C SECPRD  ROUTINE TO READ DATA FROM INPUT INTERMEDIATE TAPE                   SEC00050
C                                                                             SEC00060
C*************************************************************************SEC00070
C                                                                             SEC00080
0001        SUBROUTINE SECRD (COVMTX, AVEMTX)                                 SEC00090
0002        IMPLICIT INTEGER * 4 (A-Z)                                        SEC00100
C                                                                             SEC00110
0003        COMMON /GLOCOM/ BLANK, CARD(20), CHKOUT, COPFIL, CLASSR, CLASSX,  SEC00120
           1    CLUSTX, CONPUT, CPYOUT, CRDRDR, CRDSEQ, DATAPE,               SEC00130
           2    DUPLTP, DUPRUN, ERRMSG, FBPNT,                                SEC00140
           3    FILESV, FLDBND, HDATA, HEAD(88), ID(200), IMAGEX,             SEC00150
           4    IMARK, KEYBD, MAPTAP, MAXCHA, MAXCLS,                         SEC00160
           5    PAGSIZ, PNCH, POINT, PRESUX, PRNTR, READIN,                   SEC00170
           6    RESTRT, RUNFIL, RUNTAB(10,3),                                 SEC00180
           7    SDATA, SEPARX, SEPTPX, SPARE(10), TEMPAS(30),                 SEC00190
           8    TPSTAT(6), TTFLDX ,TYPEWR,                                    SEC00200
           9    TOP, ARRAY(12500)                                             SEC00210
C                                                                             SEC00220
0004        REAL * 8 ARRAY                                                    SEC00230
0005        REAL * 4 FRQCAL(5,30)                                             SEC00240
0006        INTEGER * 4 COMENT(16), DATE(5), HED1(16), HED2(16), TIME(5)      SEC00250
0007        INTEGER * 2 BLANK2                                                SEC00260
0008        LOGICAL * 4 CHKOUT                                                SEC00270
0009        LOGICAL * 1 BLANK1                                                SEC00280
0010        EQUIVALENCE (DATSAV,ID(1)), (CURRUN,ID(3)), (FRQCAL(1),ID(51)),   SEC00290
           1          (HED1(1),HEAD(8)), (DATE(1),HEAD(26)), (HED2(1),HEAD(39)),SEC00300
           2          (TIME(1),HEAD(58)), (COMENT(1),HEAD(72)),              SEC00310
           3          (MAPSAV,TPSTAT(1)),                                    SEC00320
           4          (SEPSCR,TPSTAT(2)), (DUPIN,TPSTAT(3)), (DASTAT,TPSTAT(4)),SEC00330
           5          (COPSER,TPSTAT(5)), (TRAOUT,TPSTAT(6)),                SEC00340
           6          (BLANK,BLANK2,BLANK1)                                  SEC00350
C                                                                             SEC00360
C                                                                             SEC00370
0011        COMMON /SECCOM/ BUFROZ,CSELEC,CSET(3,30),CSET3(3,30),THRES,CELSIZ,SEC00010
           1 CELWTH,INFO(17),INPUT, INTTAP, INTFIL, JPTS, LINES, NOCLS, NOFET,SEC00020
           2 NOFET3,NOPOOL,NWORD,NWORD2, NVR, OUTPUT, POLNAM(2,60), PREFIX(2),SEC00030
           3 PTS, RQTAPE, RQFILE, SYMCNT, VARSZ3, CSEL(30), CSEL3(30),        SEC00040
           3 FETVEC(30), FETVC3(30), POLPTR(2,60), POLSTK(60),                SEC0005C
           4 CDFLAG, CLSMAP, CSET1(3,30), OBJMAP, PHASE1, PHASE2, POLNM1(60), SEC00060
           5 PRSTAT, SYM(60), SYMMTX(60)                                      SEC00070
C                                                                             SEC00080
0012        REAL * 4 CSELEC, CSET, CSET3, THRES                               SEC00090
C                                                                             SEC00100
0013        INTEGER * 2 CSEL, CSEL3, FETVEC, FETVC3, POLPTR, POLSTK           SEC00110
C                                                                             SEC00120
0014        LOGICAL * 1 CDFLAG, CLSMAP, CSET1, OBJMAP, PHASE1, PHASE2, POLNM1,SEC00130
           1 PRSTAT                                                           SEC00140
C                                                                             SEC00150
CC                                                                            SEC00150
CCC                                                                           SEC00530
CCC                                                                           SEC00540
C                                                                             SEC00550
0015        REAL * 4 COVMTX(VARSZ3,NOPOOL), AVEMTX(NOFET3,NOPOOL)             SEC00560
C                                                                             SEC00570
0016        READ (INPUT) PREFIX, COVMTX, AVEMTX                               SEC00580
0017        RETURN                                                            SEC00590
0018        END                                                               SEC00600
```

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

LARS Program Abstract _____

MODULE IDENTIFICATION

Module Name: SECPRT **Function Name:** SECSUP

Purpose: Statistics printing and output routine for SECHO

System/Language: CMS/FORTRAN

Author: P. D. Alenduff **Date:** 4/12/77

Latest Revisor: _____ **Date:** _____

MODULE ABSTRACT

SECPRT produces tabular statistics for user information as well as carrying out minor data array processing.

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each channel. Then the information concerning classes used is printed and WRTMTX is called to print the correlation matrix. The determinant of the covariance matrices is formed by a call to SAMINV, and a check is made to determine if any determinants were zero or negative. Then SMMULT is called to produce the array SCAPRD, the scalar product, and a calculation is performed to produce the constant array. Execution is terminated if any of the determinants were zero or negative. This routine uses common blocks GLOCOM and SECCOM.

3. Input Description

Not applicable.

4. Output Description

A record type 4 of the classification format output file is written to unit OUTPUT.

Also, statistics information is produced on unit PRNTR.

5. Supplemental Information

Not applicable.

1. Module Usage

SECPRT

CALL SECPRT (COVMTX, AVEMTX, SCAPRD, DETCOV, CONST, WORK)

Input Arguments:

COVMTX (VARSZ3, NOPOOL)	R*4 Covariance matrix for each class.
AVEMTX (NOFET3, NOPOOL)	R*4 Mean matrix for each class.

Output Arguments:

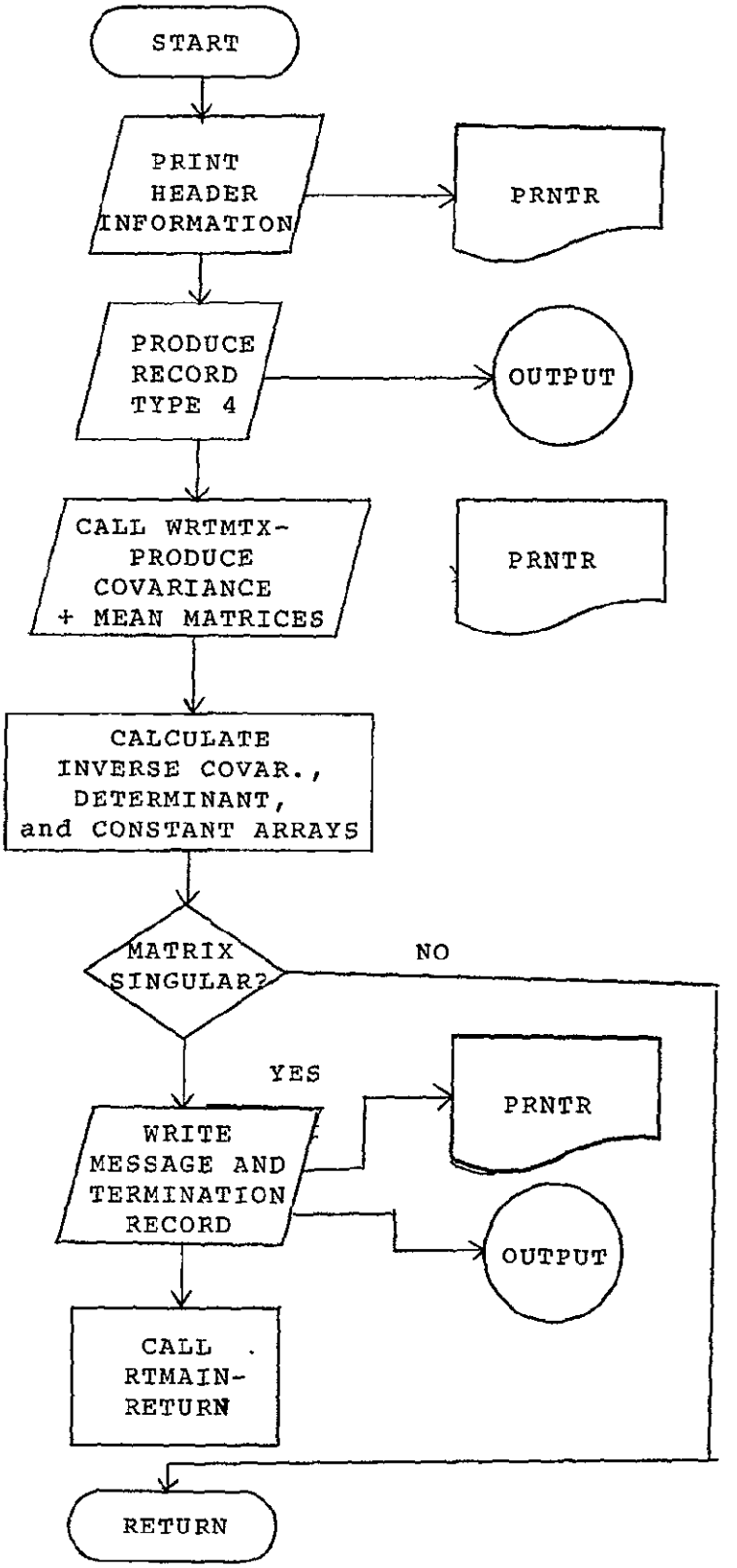
SCAPRD (NOPOOL)	R*4 Scalar product for each class.
DETCOV (NOPOOL)	R*4 Determinant of the covariance matrix for each class.
CONST (NOPOOL)	R*4 Constant formed for computation in classification for each class.
WORK (NOFET3 * (NOFET3 + 2))	R*4 Buffer array for inverting covariance matrix at least channels by channels + 2 words.

SECPRT is called to print the statistics information to be used for classification, if requested, and produce the record type 4 of a classification results format file for SECHO. Also the determinant, scalar product, and constant arrays, DETCOV, SCAPRD, and CONST, are produced for later usage.

2. Internal Description

Header information is printed on the Unit PRNTR followed by the writing of record type 4 on the unit OUTPUT. This classification format record contains COVMTX and AVEMTX, the covariance and mean matrices used in the classification for

6. Flowchart

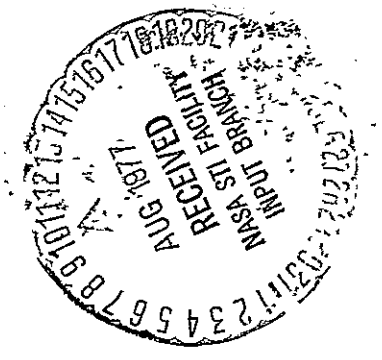

START
PRINT HEADER INFORMATION
PRNTR
PRODUCE RECORD TYPE 4
OUTPUT
CALL WRTMTX- PRODUCE COVARIANCE + MEAN MATRICES
PRNTR
CALCULATE INVERSE COVAR., DETERMINANT, and CONSTANT ARRAYS
MATRIX SINGULAR?
NO
YES
WRITE MESSAGE AND TERMINATION RECORD
PRNTR
OUTPUT
CALL RTMAIN- RETURN
RETURN

```
 FORTRAN IV G LEVEL  20.7              SECPRT            DATE = 77129        15024034              PAGE 0001
FILE SECPRT
C SECPRT     LARS   0000                                                                          SUP00010
C*****************************************************************************                  SUP00020
C                                                                                               SUP00030
C ROUTINE TO PRINT INFO FOR SUPERVISED ECHO AND WRITE INITIAL RECORDS                           SUP00040
C                                                                                               SUP00050
C*****************************************************************************                  SUP00060
C                                                                                               SUP00070
0001            SUBROUTINE SECPRT(COVMTX,AVEMTX,SCAPRC,DETCOV,CONST,                            SUP00080
               1 WORK)                                                                          SUP00090
0002             IMPLICIT INTEGER * 4 (A-Z)                                                     SUP00100
C                                                                                               SUP00110
0003             COMMON /GLCCOM/ BLANK, CARD(20), CHKOUT, COPFIL, CLASSR, CLASSX,               SUP00120
               1     CLLSTX, CONPUT, CPYOUT, CRDORR, CROSEO, DATAPE,                          SUP00130
               2     DUPLTP, DUPRUN, ERRMSG, FAPNT,                                           SUP00140
               3     FILESV, FLDBND, NDATA, HEAD(88), ID(200), IMAGEX,                        SUP00150
               4     IMARK, KEYBD, MAPTAP, MAXCHA, MAXCLS,                                    SUP00160
               5     PAGSIZ, PNCH, POINTF, PRESUX, PRNTR, READIN,                             SUP00170
               6     RESTRT, RUNFIL, RUNTAB(10,3),                                            SUP00180
               7     SDATA, SEPARX, SEPTPX, SPARE(10), TEMPAS(30),                            SUP00190
               8     TPSTAT(6), TYFLDX ,TYPEWR,                                               SUP00200
               9     TOP, ARRAY(12500)                                                        SUP00210
C                                                                                               SUP00220
0004             REAL * 8 ARRAY                                                                 SUP00230
0005             REAL * 4 FROCAL(5,30)                                                          SUP00240
0006             INTEGER * 4 COMENT(16), DATE(5), HED1(16), HED2(16), TIME(5)                   SUP00250
0007             INTEGER * 2 BLANK2                                                             SUP00260
0008             LOGICAL * 4 CHKOUT                                                             SUP00270
0009             LOGICAL * 1 BLANK1                                                             SUP00280
0010             EQUIVALENCE (DATSAV,ID(11), (CURRUN,ID(3)), (FROCAL(1),ID(51)),               SUP00290
               1         (HED1(1),HEAD(8)), (DATE(1),HEAD(24)), (HED2(1),HEAD(39)),SUPC0300
               2         (TIME(1),HEAD(58)), (COMENT(1),HEAD(72)),                            SUP00310
               3         (MAPSAV,TPSTAT(1)),                                                  SUP00320
               4         (SEPSCR,TPSTAT(2)), (CUPIN,TPSTAT(3)), (DASTAT,TPSTAT(4)),SUP00330
               5         (CCPSER,TPSTAT(5)), (TRAOUT,TPSTAT(6)),                              SUP00340
               6         (BLANK,BLANK2,BLANK1)                                                SUP00350
C                                                                                               SUP00360
0011             COMMON /SECCOM/ BUFROZ,CSELEC,CSET(3,30),CSET3(3,30),THRES,CELSIZ,SECC00010
               1 CELWTH,INFO(17),INPUT, INTTAP, INTFIL, JPTS, LINES, NOCLS, NOFET,SECC00020
               2 NOFET3,NOPOOL,NWCRD,NWORD2, NVR, OUTPUT, POLNAM(2,60), PREFIX(2),SECC00030
               3 PTS, ROTAPE, RQFILE, SYMCNT, VARSZ3, CSEL(30), CSEL3(30),SECC00040
               3 FETVEC(30), FETVC3(30), PCLPTR(2,60), POLSTK(60),SECC00050
               4 CDFLAG, CLSMAP, CSET1(3,30), OBJMAP, PHASE1, PHASE2, POLNM1(60),SECC00060
               5 PRSTAT, SYM(60), SYMMTX(60)                                                    SECC00070
C                                                                                               SECC00080
0012             REAL * 4 CSELEC, CSET, CSET3, THRES                                            SECC00090
C                                                                                               SECC00100
0013             INTEGER * 2 CSEL, CSEL3, FETVEC, FETVC3, PCLPTR, POLSTK                        SECC00110
C                                                                                               SECC00120
0014             LOGICAL * 1 CDFLAG, CLSMAP, CSET1, OBJMAP, PHASE1, PHASE2, POLNM1,SECC00130
               1 PRSTAT                                                                         SECC00140
C                                                                                               SECC00150
C                                                                                               SECC00160
C                                                                                               SUP00530
C                                                                                               SUP00540
C                                                                                               SUP00550
C                       LOCAL VARIABLES DEFINITION                                              SUP00560
C                                                                                               SUP00570
0015             REAL * 4 COVMTX(VARSZ3,NOPOOL),AVEMTX(NOFET3,NOPOOL),WORK(1),                  SUP00580
               1 SCAPRD(NOPOOL),DETCOV(NOPOOL),CONST(NOPOOL),ALOG,SQRT                          SUP00590
0016             INTEGER * 4 BCDTWO,CNT,LOC,STOP                                                SUP00600
0017             DATA BCDINC /'2'/                                                              SUP00610
C                                                                                               SUP00620
C                       LOCAL VARIABLES DESCRIPTION                                             SUP00630
C                                                                                               SUP00640
C AVEMTX = REDUCED MEAN MATRIX                                                                  SUP00650
C CNT    = PAGE COUNT                                                                           SUP00660
C COVMTX = REDUCED COVARIANCE MATRIX                                                            SUP00670
C LOC    = INDEX POINTER                                                                        SUP00680
C STOP   = INDEX POINTER                                                                        SUP00690
C WORK   = UTILITY VECTOR OF NOFET3*(NOFET3+2) WORDS                                            SUP00700
C                                                                                               SUP00710
C PRINT CLASSES AND CHANNELS CONSIDERED                                                         SUP00720
C                                                                                               SUP00730
0018             CALL GETIME(TIME)                                                              SUP00740
0019             WRITE (PRNTR,HEAD)                                                             SUP00750
```

```
 FORTRAN IV G LEVEL  20.7              SECPRT6           DATE = 77129        15024034              PAGE 0002
FILE SECPRT
0020             WRITE (PRNTR,9100)                                                             SUP00760
0021          9100 FORMAT (///,T7,'TRAINING CLASSES',T66,'CHANNELS FROM STATISTICS'/            SUP00770
               1        T7,16('-'),T66,24('-')/                                                 SUP00780
               1          //,T12,'CLASS',T45,'  CHANNEL NO.',T70,' SPECTRAL BAN SUP00790
               2 0',T96,'CAL. CODE')                                                            SUP00800
0022             J = MAX0(NCPOOL,NOFET3)                                                        SUP00810
0023             DO 150 I = 1,J                                                                 SUP00820
0024             WRITE (PRNTR,9150)                                                             SUP00830
0025          9150 FORMAT (' ')                                                                 SUP00840
0026             IF (I .LE. NOPOOL) WRITE(PRNTR,9151)   POLNAM(1,I),POLNAM(2,I)                SUP00850
0027           150 IF (I.LE.NOFET3) WRITE (PRNTR,9152) FETVC3(I),FROCAL(1,FETVC3(I)),SUP00860
               1 FROCAL(2,FETVC3(I)),CSEL(FETVC3(I))                                            SUP00870
0028          9151 FORMAT (T**',I1,'.244)                                                       SUP00880
0029          9152 FORMAT (T**',T51,I2,T69,F6.2,3X,F6.2,T95,I5)                                 SUP00890
C                                                                                               SUP00900
C WRITE RECORD TYPE 4                                                                           SUP00910
C                                                                                               SUP00920
0030             PREFIX(1) = 4                                                                  SUP00930
0031             WRITE (OUTPUT) PREFIX, COVMTX, AVEMTX                                          SUP00940
0032             IF ( NOT.PRSTAT) GO TO 200                                                     SUP00950
C                                                                                               SUP00960
C PRINT MEAN AND COVARIANCE                                                                     SUP00970
C                                                                                               SUP00980
0033             CNT = 6+(5+3+2+4+4+3*NOFET3)*((NOFET3+111)/12)                                 SUP00990
0034             CNT = PAGSIZ/CNT                                                               SUP01000
0035             INC = CNT                                                                      SUP01010
0036             DO 180 ICLAS = 1,NOPOOL                                                        SUP01020
0037             JK = 0                                                                         SUP01030
0038             DO 179 J = 1,NOFET3                                                            SUP01040
0039             WORK(J) = SQRT(COVMTX(JK+J,ICLAS))                                             SUP01050
0040             DO 179 K = 1,J                                                                 SUP01060
0041             JK = JK+1                                                                      SUP01070
0042             WORK(NOFET3+JK) = 0.                                                           SUP01080
0043             IF (WORK(K)*WORK(J) .LT. 1.0E-25) GO TO 179                                    SUP01090
0044             WORK(NOFET3+JK) = COVMTX(JK,ICLAS)/(WORK(J)*WORK(K))                           SUP01100
0045           179 CONTINUE                                                                     SUP01110
0046             IF (INC.LT.CNT) GO TO 160                                                      SUP01120
0047             CALL GETIME(TIME)                                                              SUP01130
0048             WRITE (PRNTR,HEAD)                                                             SUP01140
0049             INC = 0                                                                        SUP01150
0050           160 WRITE (PRNTR,9160) (POLNAM(I,ICLAS),I=1,2)                                   SUP01160
0051          9160 FORMAT (T0'/'OCLASS....',2A4)                                                SUP01170
0052             DO 170 LOC = 1,NOFET3,12                                                       SUP01180
0053             STOP = MIN0(NOFET3,LOC+11)                                                     SUP01190
0054             WRITE (PRNTR,9161) (FETVC3(I),I = LOC,STOP)                                    SUP01200
0055          9161 FORMAT ('0'/' CHANNEL',12I9)                                                 SUP01210
0056             WRITE (PRNTR,9162) (FROCAL(1,FETVC3(I)),I = LOC,STOP)                          SUP01220
0057             WRITE (PRNTR,9163) (FROCAL(2,FETVC3(I)),I = LOC,STOP)                          SUP01230
0058          9162 FORMAT ('0SPECTRAL',12(F6.2,1X - ))                                          SUP01240
0059          9163 FORMAT (1X,'BAND',6X,12(F6.2,3X))                                            SUP01250
0060             WRITE (PRNTR,9164) (AVEMTX(I,ICLAS),I = LOC,STOP)                              SUP01260
0061          9164 FORMAT (/'OMEAN',3X,12F9.2)                                                  SUP01270
0062             WRITE (PRNTR,9165) (WORK(I),I = LOC,STOP)                                      SUP01280
0063          9165 FORMAT ('0STD. DEV.',F7.2,11F9.2)                                            SUP01290
0064           170 WRITE (PRNTR,9166)                                                           SUP01300
0065          9166 FORMAT ('0')                                                                 SUP01310
0066             WRITE (PRNTR,9170)                                                             SUP01320
0067          9170 FORMAT ('0'/' CORRELATION MATRIX')                                           SUP01330
0068             CALL WRIMTX(WORK(NOFET3+1),NOFET3,FROCAL,BCDTWO,FETVC3)                        SUP01340
0069           180 INC = INC+1                                                                  SUP01350
C                                                                                               SUP01360
C COMPUTE INVERSE OF COVARIANCE, DETERMINANT, VECTOR AND SCALAR PRODUCTS                        SUP01370
C                                                                                               SUP01380
0070           200 DO 210 I = 1,NOPOOL                                                          SUP01390
0071             CALL SAINV(COVMTX(1,I),NOFET3,DETCOV(I),WORK)                                  SUP01400
0072             IF(DETCOV(I) .LE. 0.) GO TO 220                                                SUP01410
0073             CALL SPMULT(COVMTX(1,I),AVEMTX(1,I),SCAPRD(I),WORK,NOFET3)                     SUP01420
0074           210 CONST(I) = .5*ALOG(6.2831853**NOFET3*DETCOV(I))                              SUP01430
0075             RETURN                                                                         SUP01440
C                                                                                               SUP01450
C COVARIANCE MATRIX IS SINGULAR - PROCESSING TERMINATED                                         SUP01460
C                                                                                               SUP01470
C TERMINATE OUTPUTS TAPE                                                                        SUP01480
0076           220 CALL ERPRNT (160,'GO')                                                       SUP01490
0077             WRITE ( PRNTR,9222) I                                                          SUP01500
0078          9222 FORMAT('      SINGULAR FOR CLASS ',I2)                                      SUP01510
```

```
 FORTRAN IV G LEVEL  20.7              SECPRT&          DATE = 77129          15024034                PAGE 0003
FILE SECPRT

 0079                  IF (OUTPUT .EQ. CLASSR) CALL RTMAIN                                          SUP01520
 0080                  CALL TCPAF (OUTPUT)                                                          SUP01530
 0081                  I3 = 3                                                                       SUP01540
 0082                  K = -1                                                                       SUP01550
 0083                  IO = 0                                                                       SUP01560
 0084                  NO = FILESV+1                                                                SUP01570
                C
 0085                  WRITE (OUTPUT) PREFIX, RQTAPE, NO, I3, K, SERIAL, (IO,I = 1,7)               SUP01580
 0086                  CALL TCPEF (OUTPUT)                                                          SUP01590
 0087                  CALL TCPAF (OUTPUT)                                                          SUP01600
 0088                  CALL TCPEF (OUTPUT)                                                          SUP01610
 0089                  CALL TCPBF (OUTPUT)                                                          SUP01620
 0090                  CALL RTMAIN                                                                  SUP01630
 0091                  RETURN                                                                       SUP01640
 0092                  END                                                                          SUP01650
                                                                                                    SUP01660
```


AUG 1977
RECEIVED
NASA STI FACILITY
INPUT BRANCH